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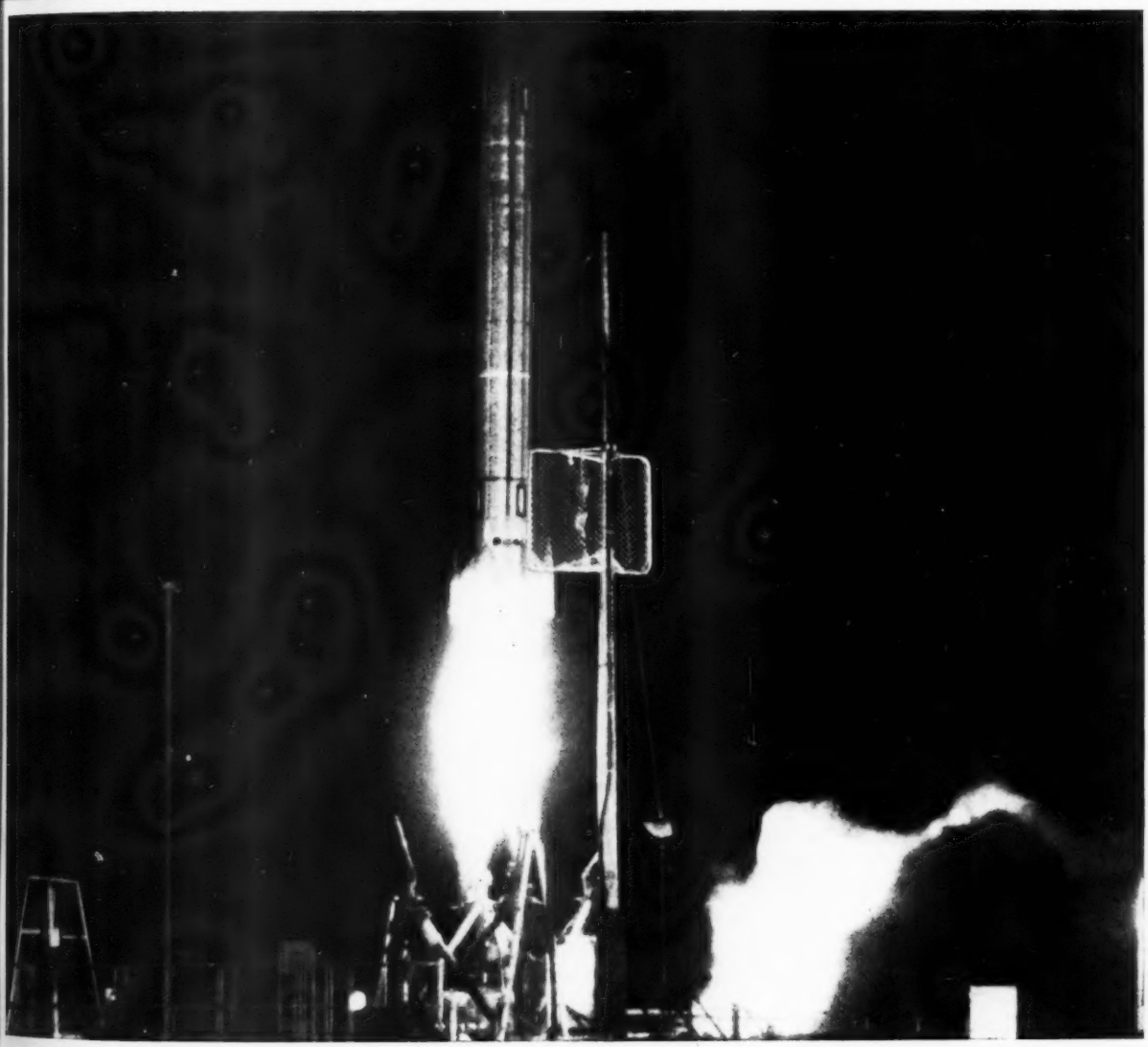

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JOURNAL OF THE INSTITUTION OF ELECTRICAL ENGINEERS

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Space research

WITH plans for British participation in space research now under discussion (this month's Foreword, p. 499) attention is turning to the facilities already available. On the cover is shown a British official photograph of the launching of a Black Knight rocket during firing tests at Woomera, Australia. This vehicle is being used for research into ballistic-missile design and development problems including re-entry into the earth's atmosphere. It has achieved a height of 500 miles, and with the Blue Streak defence rocket is being thought of as a possible means of placing a test satellite in orbit

Secretary W. K. BRASHER, C.B.E., M.A., M.I.E.E. *Editor* W. G. ASKEW, M.C.

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SPACE RESEARCH AND EARTH SATELLITES

AMONG the most outstanding outcomes of the International Geophysical Year which actually covered the period 1st July 1957 to 31st December 1958 is the incentive it gave to the use of rockets and particularly artificial earth satellites for the exploration of the extremities of the earth's atmosphere and the space beyond. As part of the organized programme of the I.G.Y. scientists in several countries were launching rockets to heights of 100 miles or more when to the astonishment and admiration of the whole world the Soviet Union launched the first artificial earth satellite (Sputnik I or 1957α) on the 4th October 1957. This was followed by the United States satellite Explorer I (or 1958α) in January 1958; and the total number of successful launchings reached double figures before the end of the I.G.Y.

These events marked the beginning of a new era of scientific research which in less than two years has engaged the attention of thousands of scientists and engineers in universities, government establishments and industrial organizations all over the world. Six of the 17 satellites launched are still travelling in orbits round our planet, and some of them with the aid of solar batteries are sending by radio their observational information to receiving stations on the earth. Two others have been dispatched into larger orbits round the sun; and the precise success of these will not be known until they return to within observational range of the earth in perhaps a year's time. And Lunik II has reached the moon.

British research in the upper atmosphere started several years ago under the auspices of the Gassiot Committee of the Royal Society. Funds were made available to meet first the expenses of the Royal Aircraft Establishment in providing vehicles and supporting facilities and secondly to assist the interested university groups to develop instruments for experiments of their own choice.

The Skylark rocket was selected as the launching vehicle, and after preliminary tests a series of fully instrumented firings was started in the spring of 1958; these included two launchings on the I.G.Y. World Day for Rockets (18th June 1958). This programme was not intended as a repetition of work already in progress in the United States and the U.S.S.R.: the experiments were devised independently and carried out in different parts of the world—at Woomera, Australia, the only permanent rocket range in the Southern Hemisphere, as well as at a middle-latitude range in Wales.

It was clear that these scientific research programmes in the different countries must continue after the I.G.Y.; and in October 1958 the International Council of Scientific Unions approved the formation of a Committee on Space Research—COSPAR—to promote and co-ordinate on an international basis all kinds of scientific experiments using rockets and satellites.

Following a preliminary meeting in London COSPAR held a second meeting in The Hague in March 1959 under the presidency of Prof. H. C. van de Hulst (Netherlands) who represented the International Astronomical Union. Although the constitution and membership of COSPAR are still being debated it has already stimulated the setting up of national committees in several countries.

The British Committee on Space Research was established under the chairmanship of Prof. H. S. W. Massey by the Royal Society as a continuation and extension of the artificial satellites subcommittee of the British National I.G.Y. Committee. The membership of the new committee, on which The Institution is represented, is very wide; and it includes all those individuals and organizations having an active interest in the subject. In the brief period of its existence it has formulated a considerable programme of scientific experiment and set up subcommittees to work out the details of tracking the satellites in which special observations are to be made, recovering the data represented by these observations, and the analysis and co-ordination of the results.

Immediately after the launching of the first artificial satellite the Nautical Almanack Office of the Royal Greenwich Observatory accepted temporary responsibility for collecting observations and issuing predictions of its position. This service passed on to the R.A.E. as the number of satellites increased; but before the end of

the I.G.Y. it was transferred to the D.S.I.R. Radio Research Station at Slough where a World Data Centre for rockets and satellites had already been established to collect and exchange data with the other two centres in Moscow and Washington.

In this manner provision was made for the collection and co-ordination of results on an international basis including contributions from countries which did not intend to launch satellites but were interested in carrying out observations and even in suggesting special experiments which might be attempted in future satellites.

In May 1959 the Government announced that a British programme for the design and construction of instruments to be carried in artificial earth satellites had been approved and that work would begin at once under the general advice and supervision of the British committee. At the same time it was decided that a team of experts under the leadership of Prof. Massey should go to America to discuss with the National Aeronautics and Space Administration—NASA—the active co-operation between the two countries in programmes of space research.

In particular the British team explored in detail the conduct of some special experiments for which space in American satellites would be made available for scientific instruments developed in this country. As was announced by the Lord President of the Council on the 29th July 1959 these discussions were entirely successful, and British scientists will prepare instruments for satellites to be placed in orbit by a new U.S. rocket vehicle 'Scout' which is now under development by NASA for use in connection with civil scientific research.

The experiments envisaged relate to such subjects as the measurement of the electrical properties of the upper atmosphere, radio-wave sounding of the ionosphere from above it, measurement of ultraviolet and other radiation from the sun free from absorption in the earth's atmosphere, and study of the earth's magnetism and gravitation at very high altitudes.

Financial provision has been made to enable the university groups to initiate the development of experimental techniques and apparatus; but the interested Government groups, particularly the Department of Scientific and Industrial Research, the Meteorological Office and the Ministry of Supply, will conduct their part of the programme from their normal budgets. The Royal Society committee will advise on the scientific experiments to be undertaken, while an independent steering committee under the chairmanship of Sir Edward Bullard has been appointed by the Lord President of the Council to supervise the Government's space-research programme and co-ordinate the arrangements for its execution.

These provisions are however intended as a first step in a longer-term programme in which suitable rockets may be developed, perhaps by the adaptation of military units, to enable British satellites to be launched independently of other assistance. For the realization of this goal the experience to be gained by taking advantage of the American offer will be invaluable.

COSTS OF POST OFFICE BUILDINGS REDUCED

In 1957 a joint Post Office and Ministry of Works research and development group was set up to investigate ways of making the annual £10 million allotted to the Post Office for new buildings go further. Their task was to concentrate on specific kinds of buildings such as telephone exchanges, post offices and engineering depots and to see how building costs could be reduced by better arrangement and by taking fullest advantage of recent developments in the field of telecommunication engineering.

Designs have now been completed for two typical buildings—a 10000-line automatic telephone exchange to be built at Altrincham, Cheshire, and a head post office at Hitchin, Hertfordshire. Although the exteriors will be modified to harmonize with particular surroundings the basic principles and lessons learnt will be applied to all future buildings of the same types.

In planning the Altrincham exchange use has been made of independent development work by the P.O. Engineering Department on the design of telephone-exchange equipment. A new lay-out of switching apparatus means that space is utilized which would otherwise lie idle until the exchange became fully loaded, which might be up to 15 years after completion.

Space is saved by employing a simplified main distribution frame and also by using mains rectifiers for power supply instead of motor-generator equipment. A basement cable chamber has also been dispensed with; the Altrincham exchange is in fact a single-storey building. Cables enter above ground and are carried along the inner face of the external wall of the apparatus room.

The estimated cost of the Altrincham exchange is £27000, less than half the cost of a building of similar function and capacity designed in the conventional manner. Subscriber trunk dialling will be installed, and provision has been made for extension with minimum disturbance of the automatic switching equipment. Of the total area 98·8% will be working space and only 1·2% circulating space. Construction which begins in October 1959 is expected to be completed by 1962.

The cost of building the Hitchin post office will be £63000 as against an original estimate of £100000, and it should be ready for use in 1961. The joint group is now planning an engineering depot.

P. V. HUNTER—ELECTRICAL ENGINEERING IN OUR TIME

The late Philip Vassar Hunter, a former President and an Honorary Member of The Institution, won world-wide respect for his work on cable design, his wartime contributions to submarine detection and mine-sweeping, and his valuable guidance on committees. It is most fitting therefore that his memorial each year should take the form of a lecture given by an electrical engineer to electrical engineers.

This article is a shortened account of the First Hunter Memorial Lecture which was delivered on the 8th January 1959 (see March 1959 Journal, p. 199) by Mr. C. O. Boyse who is Managing Director of Automatic Telephone and Electric Co. Ltd. The three-quarters of a century spanned by P. V. Hunter's lifetime included two world wars and was a period of intense engineering activity. Mr. Boyse reviews the highlights of Hunter's career and electrical engineering developments of the time and considers probable future trends.

C. O. BOYSE, B.SC.(ENG.), MEMBER

THE story begins in 1883—sixteen years after the death of Faraday and five years before the Society of Telegraph Engineers and Electricians became The Institution of Electrical Engineers. For in that year was born Philip Vassar Hunter whose life and work are being commemorated by the series of Lectures which I have the privilege of inaugurating. His death at the age of 73 came with dramatic suddenness to bring to an end a full life during which he was regarded with affection by his many friends, with trust and admiration by his colleagues, and with respect as a talented engineer all over the world.

The mere statement that Hunter was born in 1883 conveys little; yet the date had a profound influence on the outlook of the man and on his work as an engineer in the years to come.

1 *Philip Vassar Hunter*

His early environment

What was the state of electrical engineering in 1883? Strictly speaking, apart from a few arc-lighting enthusiasts there was no such animal as an electrical engineer. Although over 50 years had elapsed since Michael Faraday's discovery of the principles of electromagnetic induction most electrical workers were 'weak current' men devoting their lives to the advancement of telegraphy and telephony. And the telephone invented by Graham Bell in 1876 was in its infancy.

Electric power engineering was only just beginning, and in 1882 had occurred two events of importance in the field of public electricity supply in Britain. The first was the passing of the original Electric Lighting Act and the second was the putting into operation of London's first public power station at Holborn Viaduct. The following year Edison provided the newly erected and only recently demolished Holborn Restaurant with 1800 incandescent lamps supplied by twin mains of 0·75 in.^{2} sectional area.

The motor car unknown

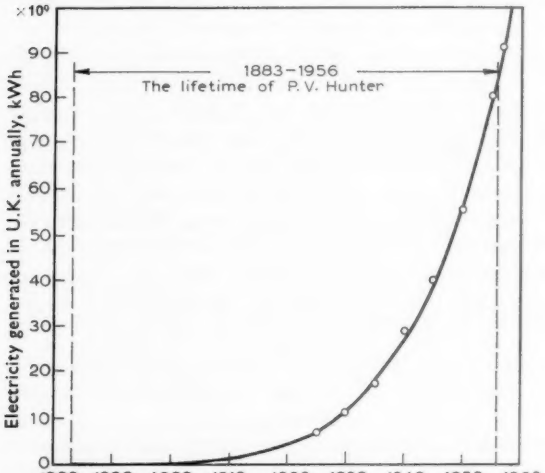
But lighting and telephony were only the first of the amenities of modern civilized life that the electrical engineer brought into being. One of the two greatest inventions of the closing years of the 19th century was undoubtedly the internal-combustion engine; and it is of interest to note that this—an invention of the mechanical engineer—was made really effective only by the introduction of electrical ignition. From this one source stemmed the motor car and the aeroplane, both entirely unknown in 1883.

The other great invention, which dates from 1884 and to which I shall revert later on, was that of the steam turbine by Sir Charles Parsons: a mechanical invention without which the tremendous output of the modern electrical generator could never have been attained.

To these have been added in recent years radio and television, both of them fantastic and visionary concepts when H. G. Wells wrote of them as far back as 1898. All these things were unknown in the pleasant, leisurely age of the early 1880's, and all were to be developed within a short span of years by the efforts and ingenuity of the electrical engineer.

The extent to which electric power has superseded or

augmented that of men and beasts is shown in Fig. 2. This illustrates the extraordinary rate of increase in the growth of the British electricity supply industry during the three-quarters of a century which was Hunter's lifetime.



2 *Growth in use of electric power in Hunter's lifetime*

With all this in mind we can see how P. V. Hunter, born of Norfolk farming stock, passed his early boyhood in an era of development of electric power, and this undoubtedly influenced his choice of a career when the time came.

The schoolboy's inspiration

During his schooldays at Wisbech Grammar School one of the outstanding personalities of the time was Sebastian de Ferranti. To a schoolboy brought up in agricultural surroundings there was something inspiring in the career of this young man who in his early twenties had built at Deptford the biggest power station in the world with alternators generating at 10kV; and Hunter's admiration and affection are reflected in the reference in his Presidential Address to The Institution 40 years later to Ferranti as the 'father of electricity supply'.

By the time he was 16 Hunter had decided to become an electrical engineer. His father was gravely disapproving: a farmer was his own master, but an electrician was a mere paid employee. But what appeal had such advice when set against the shining example of young Sebastian de Ferranti? He made his decision and won a scholarship to Faraday House where from January 1900 to May 1904 he followed the conventional 'sandwich' course, being placed third in the honours list.

I would like here to quote from Hunter's own Jubilee Lecture delivered to the North-Eastern Centre in 1949 when he referred to the beginning of his long association with Tyneside in 1904.

'I was in my twenty-first year, and although there were already some indications that Tyneside was preparing to play an important part in the development of electric power supply, he would indeed have been a bold man who predicted the enormous part which the area was destined to play in pioneering the production, transmission and utilization of electricity for the benefit of the whole community.

'My steps were directed to Newcastle quite by chance as the result of answering an anonymous advertisement in the technical Press, but, looking back over the 12 years which I spent in Newcastle from 1904 to 1916, I think that no young electrical engineer, even if he had known all that we know now about the progress and development of electricity, could possibly have chosen throughout the world, not excluding America, a more interesting and formative district in which to exercise his energies.'

Fig. 3 shows the final page of Hunter's letter replying to the advertisement in the *Electrical Review* which proved to be for an assistant in the electrical section of Merz and McLellan at Newcastle. He appears to have 'stretched' his age a little, but he got the post and became one of the electrical team under the leadership of Bernard Price. He settled for a commencing salary of £140 per annum.

Carville power station

When Hunter took up his appointment Carville power station, the first large-scale exploitation of Parson's new and revolutionary steam turbines, was only partially completed.

Neptune Bank, the finest generating station in the United Kingdom and the pride and joy of the north-east coast, had been completed only three years before. Designed by Charles Merz, with large triple-expansion engines and built—strange to say—by the Wallsend Gas Co., it had been opened in a blaze of publicity by Lord Kelvin in June 1901. Yet at the age of three it was already about to be eclipsed by the new Carville station. It was against this background and in this very area that Hunter was to begin his professional career.

He was fortunate too in having as his chief and his departmental head respectively Charles Merz and Bernard Price. Merz had his own conception of universal and economic electricity supply on a colossal scale, and Price was a fanatical enthusiast where electrical progress was concerned.

One of the unforeseen effects of the large-scale interconnected high-voltage networks which were laid down on Tyneside in the next few years was the difficulty of localizing a fault to the feeder immediately concerned. Merz and Price between them evolved a discriminating form of protection, and their system proved a valuable contribution to stability of supply. It was however a somewhat insensitive method and expensive in that it involved the use of a separate pilot cable.

Filling the vacuum

In 1909 Price left the firm to undertake the management of the Victoria Falls and Transvaal Power Co., and the sequel is best described in Hunter's own words:

'There was no one fitted to take over his work and responsibilities, but I was called on to fill the vacuum to the best of my ability.

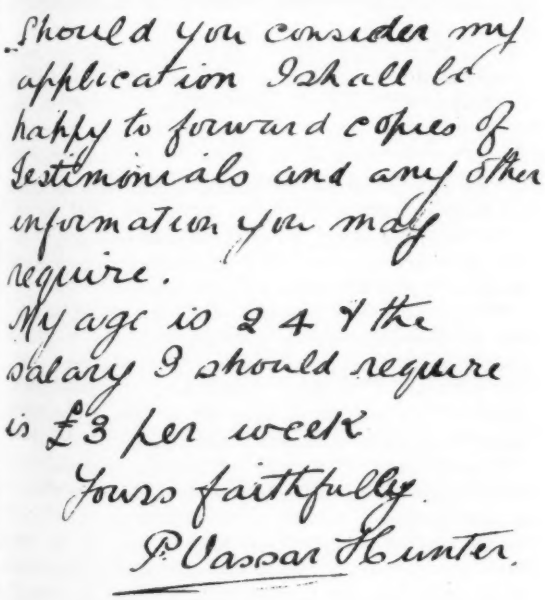
'There were three young engineers associated with me and

since our chief, Charles Merz, had decided to let us "have a go"—in the words of Wilfred Pickles—without calling in some senior engineer from outside to run the department, we agreed to make up as a team what we lacked in experience. Those who were associated with me in this interesting and fruitful team—I quote their names in order of seniority in joining the firm—were R. W. Gregory, J. R. Beard and W. Dixon. We had as juniors Thornton, Lisle and Waggott, and some draughtsmen.'

This remarkable team is shown in Fig. 4.

A problem which early engaged Hunter's attention was the need for a more satisfactory and discriminatory form of protection than the Merz–Price system referred to earlier. The use of a separate pilot cable in particular seemed to him an undesirable feature; and the outcome was the Merz–Hunter split-conductor system patented in 1911.

In this each of the 3-phase conductors was split into two equal components lightly insulated from each other, and any out-of-balance condition produced on any phase actuated the trip mechanism and cut the feeder out of service. The


Should you consider my application I shall be happy to forward copies of testimonials and any other information you may require.
My age is 24 & the salary I should require is £3 per week
Yours faithfully.
P. Vaasar Hunter.

3 *Last part of Hunter's application*

experimental lengths were made by Thomas Callender at his works at Erith.

After the departure of Price for South Africa Hunter remained at Newcastle for five years, acquiring from the day-to-day work of the firm and particularly from the influence of Charles Merz a lively interest in power-station economics, switchgear, prime movers and cables, an interest destined to provide a catholic background to his work in later years as a cable maker.

Development of Asdic

Then came 1914 and the First World War. By 1915 the Admiralty belatedly recognized that the engineering talent in the country was not being effectively utilized and appointed Charles Merz director of experiment and research.

Merz proposed the formation of small specialist teams each comprising an Admiralty representative, a scientist and an engineer. In 1917 when the submarine menace became a desperately urgent problem one of these teams was formed to aid the branch dealing with submarine detection. The Admiralty was represented by Admiral W. W. Fisher, and the scientist was Sir William Bragg. The third member—the engineer—was P. V. Hunter. Their efforts culminated in the successful development of the now-famous Asdic equipment, and in 1920 Hunter's major contribution to its effective introduction was recognized by his appointment as C.B.E.

In January 1919 the committee was disbanded, and he rejoined Merz and McLellan in their London office.

Post-war impetus

During the war years the demands for electrical power had stretched existing sources of supply to the uttermost, and the end of the war gave impetus to the pent-up demand for a supply of power cables and plant enormously in excess of anything previously contemplated. Callender's Cable and Construction Co. under its 64-year-old managing director, Sir Tom Callender, found itself nearly overwhelmed with a flood of orders, and seeking a chief engineer of high ability Sir Tom approached P. V. Hunter, now looking for new worlds to conquer. So, on the 1st June 1919 began the association with the company which was to lead to Hunter's international recognition and to last until his death 37 years later.

Since Ferranti's introduction of the 11kV single-phase system in 1889 the only advance in transmission voltage had been that of the early 1900's when cables for operation at 20 and even 25kV were installed. Even these were not wholly trouble-free, and there was a general reluctance as late as 1920 to embark on the production of 33kV 3-phase cables.

The troubles that did in fact follow the large-scale production of these cables are now a matter of history, as is the design associated with the name of Martin Hochstadter to overcome their inherent defects.

Ordered thinking

Hunter's reaction within his own organization was to concentrate on the much needed improvement in quality both of materials and of production methods which he found in use. Progress in cable design and manufacture was still, as in the early days of cable making, largely empirical, and the ideal of 'ordered thinking' was only now being urged on an industry which had for long relied on traditional methods and rule-of-thumb calculations.

Hunter's twin aims at this stage were the building of a really first-class research station and the creation of a system of quality control. In due course both came into being.

His inventive mind was never idle; and soon after joining Callender's he revived an earlier idea for an improvement on the Merz–Hunter type of protection. Thus emerged the

Callender–Hunter system in which only one of the conductors was split and the two halves were connected at each end through opposed windings of a transformer in such a manner that the out-of-balance e.m.f.'s due to a fault operated a relay and cut the cable out of service.

During the 20 years from the date of his joining Callender's to the outbreak of war in 1939 Hunter gradually established himself both in his own country and internationally as one of the great cable engineers.

A very young President

Abroad he was well known and respected as a member of council of the International Conference on Large Electric Systems (C.I.G.R.É.) and a national delegate to the International Electrotechnical Commission. In his own country he was identified for many years with the work of The Institution on regulations for the wiring of buildings and the electrical equipment of ships. When in 1933 he was elected President of The Institution he was one of the youngest ever to hold office; and in 1951 he received that highest distinction to which an electrical engineer can aspire—the award of Honorary Membership.

Throughout his career he had been an enthusiastic student of the history of power-cable development. Beginning with his high regard for Ferranti and his famous tubular mains he had had first-hand acquaintance with most of the types of cable later developed for ever-higher voltages. He infected his personal assistant J. T. Hazell with much of his own enthusiasm; and together they not only collected—and eventually presented to the Science Museum—a unique collection of examples of all the major types and variants of power cable manufactured but also produced in 1956 their admirable book 'Development of power cables' much of which was based on Hunter's own recollections of a lifetime in the industry.

Gas-pressure cables

His greatest personal contribution to this continuous development was his championship of the direct gas-pressure type of cable. Pressure cables had been projected by Fisher and Atkinson in America in the early 1920's, but it was only in Great Britain and Germany that any really intensive practical work was done on them. Among the eminent British advocates of the gas-pressure cable one finds the names of Beaver and Davey, Bowden, Dunsheath, and Hunter and Brazier.

Hunter persuaded Major Richardson of the Metropolitan Electric Supply Co. to put down the first full-scale commercial installation of direct gas-pressure cable, and they both virtually staked their professional reputations on the result. The cable did in fact give excellent performance and their faith was triumphantly justified.

Buoyant cables for minesweeping

Meanwhile however and for the second time in his career his engineering genius was called on to help solve an essentially wartime problem in electrical engineering.

The story of the introduction of the German magnetic mine, of the recovery of an unexploded mine at Shoeburyness on the 22nd November 1939, and of its subsequent disarming by Lt.-Cmdr. Ouvry is familiar to us all. As a record of cool courage it is one of the dramatic stories of the war.

But the stripping down of the hidden mechanism of this new war hazard was only the necessary prelude to the evolution of appropriate devices for its destruction; and this part of the story—the speedy and effective measures taken to deal with the menace and the part played in that development by British cable makers—is not so widely known.

4 *A notable and promising group*

Left to right (back row) A. J. Sedgwick, G. S. Lisle, S. H. Ashton, J. Melvin, W. Dixon; (centre row) J. R. Beard, P. V. Hunter, R. W. Gregory; (front) W. N. Waggott

The first attempts at magnetic sweeping were carried out—with indifferent success—by low-flying aircraft carrying energized coils. The real problem was to provide a cable which was intrinsically buoyant, would carry intermittently a current of 3000amp (at a negligible voltage), and could be towed at high speed and coiled on deck when not in use.

It soon became clear that the required combination of buoyancy and current-carrying capacity could not be achieved by surrounding a normal cable with buoyant material. Hunter quickly conceived the idea of turning the cable inside out so that the conductor instead of being in the centre would be located around the periphery in the form of a thin annulus of wires, the whole of the central portion being filled with the buoyancy medium.

By this invention he overcame all the difficulties which had frustrated the earlier attempts at designing a buoyant cable. The conductor with its greatly increased radiating surface separated from a continuous supply of cooling water by a thin insulating layer only, operated in such excellent thermal conditions that it could be worked intermittently at a current density as high as 6000amp/in.^{2}; and 0·5in.^{2} conductor adequate to carry the 3000amp required needed a core of only 3in.-diameter cellular ebonite cylinders to make it float. A trial length fulfilled all expectations and enabled proposals to be placed before the Admiralty on the 23rd December 1939.

This radical departure from traditional cable-making

practice which established the basic design of all buoyant cables used throughout the war is an excellent example of one of Hunter's outstanding gifts, that of being able to select the essentials from a complex mass of detail, strip the problem of irrelevances and propose a solution with clarity and decisiveness.

Broader trends

In this the first Memorial Lecture I have not unnaturally devoted much time to the life and work of Hunter himself. But I do desire in addition to refer to certain broader aspects and trends of electrical engineering which arise naturally from a study of his career.

We have already noted the spectacular growth of electric power in recent years. Similarly the science of telecommunication has made tremendous strides. In other words the objects for which The Institution is constituted—'to promote the general advancement of electrical science and engineering and their applications and to facilitate the exchange of information and ideas on those subjects amongst the members of The Institution and otherwise'—are being fully achieved.

On the power side the increase in the availability of electrical energy has depended largely on the increasing size of alternators. This in turn was made possible by the invention of the steam turbine which as mentioned earlier may rightly be regarded as one of the most important single events so far in the history of electric power engineering.

The exploitation of nuclear energy marks the beginning of a new era which will surely result in the evolution and application of new principles in the generation of electricity. Important developments too may be expected in the harnessing and exploitation of solar energy and in the use of natural gas.

But whatever we may see in the way of new primary sources of energy there is no indication yet that the vast majority of applications will be other than through the medium of electricity. The part to be played by the electrical engineer of the future must therefore surely be one of continual growth. Improvements in standards of living, increasing population, and still further applications of electric power will stimulate all the inventive ability which our profession possesses.

A direct future?

Looking to the future of transmission it is accepted that high-voltage d.c. transmission by overhead line or by underground or submarine cable has certain important advantages over that of alternating current but it requires expensive terminal equipment.

The over-all economy of individual cases thus depends on circumstances, the relative advantages of direct current increasing with length of line and load to be carried. It has been said that apart from the d.c. submarine-cable cross-Channel link which is clearly a special case there is little scope in the United Kingdom for high-voltage d.c. transmission. Whether this remains true or not it is clearly necessary for the British electrical industry to undertake such development work as is necessary to enable it to compete in the international field.

On the utilization side electric power is demanded in practically every field of human activity. It may perhaps be appropriate here to mention specially electric railway traction of which we now see rapid growth not only in Britain but also in many other parts of the world.

The present trend in appropriate cases seems more and more towards railway electrification at high voltage and standard frequency. This system enables important economies to be achieved in the cost of overhead equipment, substations, etc. On the other hand telecommunication interference problems may be aggravated, more particularly in highly developed countries.

Long-distance vision links

In the field of telecommunication there have been many remarkable new developments. At the joint meeting in January 1957 when London, Montreal and New York were linked over the transatlantic telephone cable for technical discussion of this fine achievement the clarity of the speech and the outstanding quality of high-fidelity music transmissions over the cable were almost uncanny.

The first joint meeting linking distant cities by vision as well as by sound can hardly be far away. A glimpse of other future possibilities has recently been seen in the radio signals carrying the human voice to the moon and back again in the form of an echo.

To the broad and extensive subject of electronics generally I will only make a passing reference. Its applications are legion, but it is natural that we are now hearing much of the more spectacular aspects such as machine-tool control (or automation), data-processing, and the growing use of computers of all types. Many established practices are undergoing revolutionary changes as a result.

Interdependence of engineers

Although this lecture deals essentially with electrical engineering I have a special reason for wishing to refer to civil and mechanical engineering matters. This is not with the idea of making comparisons between the respective rates of progress although it is probably true that in many respects electrical engineering has made the most spectacular strides in the last 75 years. What I want to emphasize is the growing interdependence between the different branches of engineering.

I have already mentioned the part which electrical ignition played in the evolution of the internal-combustion engine and similarly the importance to alternator development of the introduction of the steam turbine as a novel form of prime mover. Mechanical and structural design problems are inseparable from the electrical properties of machines and transmission lines.

These are all pointers to the same conclusion. No engineer, however specialized his field, can afford to work in isolation; and here perhaps I may say a word in appreciation of the strong spirit of co-operation which now exists between us and our sister institutions. This has not always been so, and great credit is due to those whose breadth of outlook has done so much to bring it about.

Confusion of thought

I would like here to digress for a moment if only to refute those who affect to regard all engineers as Frankensteins and every material advance as an invention of the devil.

The fundamental characteristic of an engineer has been well defined as the capacity for ordered thinking, to which one may add—and the Charter of the Institution of Civil Engineers specifically does so—'for the use and convenience of man'. Not, it should be noted, 'for the spiritual welfare of mankind'; his aim as a professional man is one of material progress and not of ethics.

Engineers are constantly assailed on a basis of most 'disordered' thinking by moralists for the perversion of their achievements by criminals, cranks and politicians; and by cynics for their indifference to the incidental distress inseparable from general progress. Following such confused thinking to its logical conclusion we should condemn Lilienthal for the bombing plane and Sir James Simpson for the misuse of cocaine and morphia in our own time.

The elder statesman

On this philosophical note we might well pause to contemplate the last phase of Hunter's career when it was natural that he should be regarded in the role of elder statesman. It was then that his special qualities were most apparent to others. His capacity for clear thinking enabled him to reduce a problem to its essential terms—a faculty which made him such a wise counsellor in committees.

He had outstanding tenacity of purpose and the ability to delegate responsibility in such measure as to bring out the best in others. He was moreover always a realist; and in his Presidential Address he laid stress on the proposition—now accepted as an axiom—that an engineer's creation must not only work but also pay.

Fundamentally the engineer's objective may be defined as the need to produce something which will nearly break down. I have used this rather provocative phrase before, but I repeat it now as it does illustrate that vital principle of compromise between uneconomic cost and inadequate performance.

Ordered thinking; tenacity of purpose; delegation of authority; humanity; integrity; and realism. These are the characteristics for which P. V. Hunter will be remembered, and these and the philosophy behind them may well be regarded as a standard to be cultivated by other engineers in their professional lives.

Recognition of imaginative thinkers

Membership of our Institution carries with it important responsibilities in these matters not only in sustaining the requirements laid down for our professional qualifications but in fostering the vigorous exchange of ideas on electrical science and engineering, whether these ideas be orthodox or unorthodox. I will not dwell on this subject as it may have its controversial side, but there is perhaps room for another class of member which would provide for the imaginative thinker who has not the time or patience to comply strictly with our requirements on education, training and experience.

In bringing this lecture to a close I realize full well that it will be followed by others more ably composed and presented. Whatever the topics chosen in the future, whether they be based on particular branches of electrical engineering or on the achievements and influences of outstanding personalities, I feel sure that the series of Hunter Memorial Lectures will fill a gap in our present programme of meetings.

The gap existing between the popular appeal of the Faraday Lecture and the deeper scientific nature of the Kelvin Lecture is emphasized by the trend towards more and more specialization in the technical papers read before Ordinary Meetings and the Sections. The Hunter Lectures will however provide recurring opportunities for a broader treatment of more general aspects of the ever-expanding field of electrical engineering.

By the doorman of a famous hotel not a hundred miles from The Institution Hunter may have been regarded as 'the electrician from next door', but to those of us who knew and worked with him he was an electrical engineer in whose footsteps we are proud to follow. I have a special pride in paying my own tribute by being privileged to deliver this First Hunter Memorial Lecture.

Summary

Electric power engineering from its beginning in the early 1880's when Hunter was born made tremendous strides following the invention by Parsons of his steam turbine. This was accompanied by corresponding advances in the techniques of overhead and underground transmission and distribution and of utilization.

Hunter's own work in these fields on Tyneside and with Callender's Cable and Construction Co., his Asdic and buoyant-cable achievements, and his world-wide reputation as an electrical engineer and cable maker are described. His qualities and philosophy may well be cultivated by electrical engineers following in his footsteps.

PROFESSIONAL ENGINEERS APPOINTMENTS BUREAU

All the functions of the Professional Engineers Appointments Bureau have been transferred to an Appointments Division of the Engineers' Guild, and its activities will in future be directed by the Professional Engineers Appointments Board which has been set up by and will be responsible to the Guild.

The separate existence of the Professional Engineers Appointments Bureau has thus been terminated. The Registrar and Secretary of the Bureau and the Assistant Secretary will continue to serve in similar capacities in the new Division of the Guild.

The Professional Engineers Appointments Bureau was set up in 1945 with the help of the engineering industries to assist in the resettlement of professional engineers on their release from their wartime duties; when that task had been fulfilled the Bureau found that it could offer, and it has continued to offer, a service which is of value to employers and to members of the profession.

621.395.44 Rural communication systems

The increasing cost of providing wire circuits to rural telephone subscribers and communities has necessitated the adoption of various measures including carrier telephone systems to increase the efficiency of usage of such circuits.

In this article the author considers the requirements and special problems of carrier systems for this purpose and the way in which these requirements are being met. Mr. Barker is with Standard Telephones and Cables Ltd.

A. J. BARKER, B.A., ASSOCIATE MEMBER

THE economic provision of a satisfactory telephone service to subscribers in sparsely populated rural areas has always been one of the most difficult problems of telephone administrations. Since 1945 this problem has become more acute because of the rising cost of constructing the open-wire lines normally used for such service and the growing demand for circuits.

To deal with this situation the party-line system has been adopted in many countries: up to ten subscribers share a common exchange line, calling being arranged by coded or selective ringing. A more satisfactory method of sharing exchange lines between subscribers, which may be applied in some rural areas, is the line concentrator or connector by which exclusive service may for example be provided to ten subscribers over two exchange circuits. The line connector is essentially a switch which connects the exchange circuits to the various subscribers as and when required. It is located at a suitable focal point in the subscribers' district.

Carrier telephony has been used for over 30 years to increase the capacity of trunk telephone lines and is now the normal method of providing long-distance circuits. For many years this method has also been used—to a very limited extent—to provide additional rural circuits, but only with the development of new techniques and components, in particular the transistor, has it become technically and economically practicable to employ carrier telephone systems for these applications. In the past two years several designs of rural carrier telephone system have been successfully introduced.

Special requirements of rural carrier systems

The essential technical difference between a rural carrier system and a conventional carrier telephone system is that the several circuits of the former must be capable of terminating in separate and frequently remote locations. And whereas in conventional systems many circuits can share such features as power supplies, maintenance facilities, oscillators for supplying carrier-frequency currents and tones for signalling purposes, much of the high-frequency circuitry, and building accommodation, in the rural system each of these has to be capable of being provided for each circuit terminal independently or sometimes in small groups.

It must also be possible to add to the system one circuit at a time without interference with those already in use, and the system should not interfere with any trunk-circuit systems operating on other pairs on the same pole route. The crosstalk level must be satisfactory even though lines may not have been constructed for carrier-frequency working. The system should be economic for distances at least as short as ten miles but should give satisfactory operation up to 50 miles or more.

Power supplies and maintenance

Owing to the wide dispersion of the carrier terminals the cost of a single visit by maintenance personnel may be of the same order as a subscriber's annual rental, although the cost of planned routine visits is substantially less than that of unscheduled emergency calls.

Success therefore depends on the system requiring little or no maintenance, at least at the remote terminals. This immediately puts any equipment employing thermionic valves at a serious disadvantage since normal valves require replacement at intervals of from about one to three years if operated continuously. In addition they consume a substantial quantity of power which must either come from the public mains supply or be generated or stored locally.

In rural areas where a reliable mains supply is not available it would be quite uneconomic to provide a local source sufficient to feed a valve-operated equipment, bearing in mind that the equipment would need to be kept switched on continuously, first to listen for incoming calls and secondly because it is undesirable to impose a delay to allow the valves to warm up before the circuit could be used.

Provision of power over the telephone wires has been considered as this has proved highly successful in certain cable systems, but the variability and vulnerability of open-wire telephone lines make this impracticable at present.

For limited applications, systems have been used for many years in which the remote terminal contains no active elements and does not therefore require any power supply. Generally these systems provide one carrier circuit in addition to the audio circuit on one open-wire pair. The principles of operation of such systems are illustrated in Fig. 1.

The carrier frequency is generated at the central terminal only and is transmitted to the remote terminal where a single modulator circuit operates in both directions. As shown the system is arranged for magneto ringing. One system of this type has been expanded to provide two carrier circuits.

It is possible to extend the principle partially to systems providing more than two additional circuits, but a number of difficulties arise. In the first place it becomes necessary to reintroduce some active equipment at the remote terminal for signalling purposes since it is necessary to use carrier-frequency signalling methods to obtain sufficient signalling paths. Secondly the length of the circuits thus obtained is severely restricted, mainly by the lack of amplification at the remote terminal.

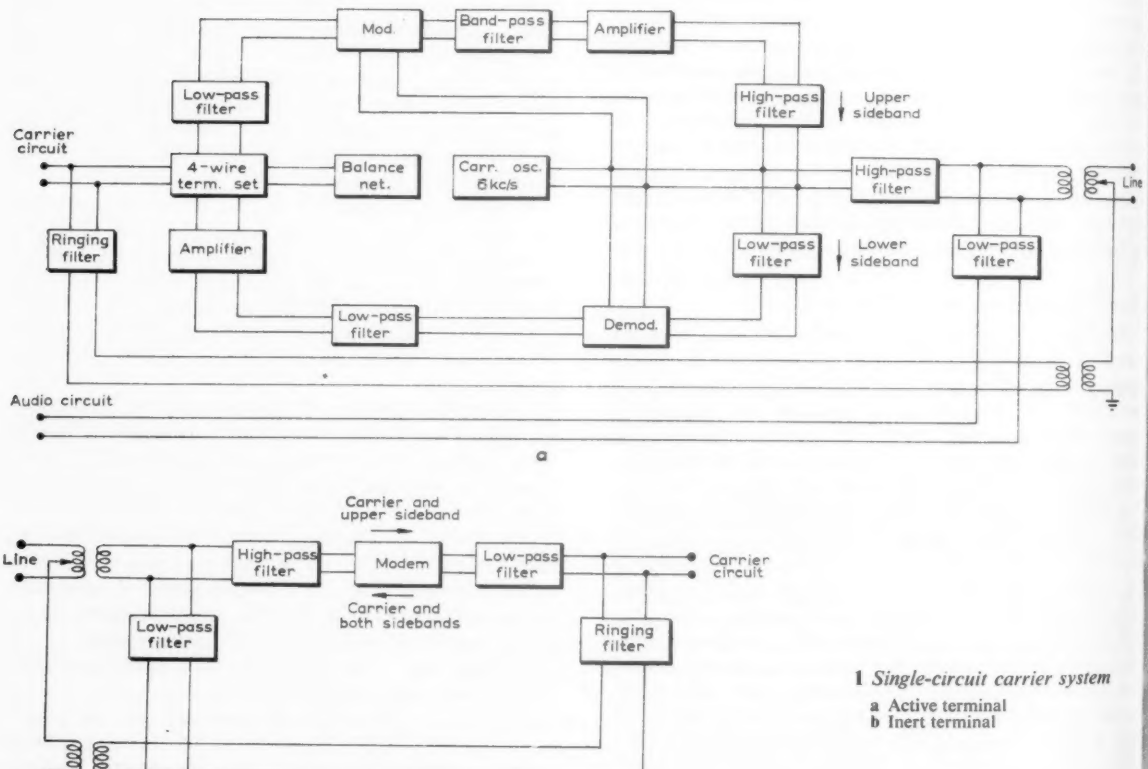
Low consumption of transistor circuits

The problems of providing power supplies and keeping maintenance costs sufficiently low have therefore been main factors restricting the introduction of rural carrier systems. The advent of transistors however has made it possible to solve these problems since equipment employing transistors consumes only about one-tenth of the power used by equivalent circuits employing valves and requires a lower and more convenient voltage. Moreover since no warming-up period is required much of the equipment may be switched off when the circuit is idle, thus further reducing the power consumption. The very long life of these components also contributes to low maintenance costs.

Depending on the facilities required the consumption of the transistor circuits at a remote terminal ranges from less than 0·5 watt for the most elementary system to nearly 3 watts for the most versatile equipment. To this must be added microphone current and the energy required to operate associated relay equipment and subscribers' bells which together may average a further 1 watt.

Various means of providing this power have been examined including many types of primary and secondary battery as well as less obvious methods such as solar batteries and wind generators. Methods in the latter category require further development but may eventually provide an ideal solution. In the meantime economic studies in several countries have shown that of the batteries at present available primary cells of the air-depolarization type are the most suitable. Using a housing of about the same size as that required for one circuit terminal, battery lives of from six months to two years are expected.

Where more than a very few circuits are required at a station without existing batteries or a mains supply it becomes economic to install a compression-ignition engine and generator.



1 *Single-circuit carrier system*
a Active terminal
b Inert terminal

Modulation methods

Even with transistor equipment the cost of batteries and maintenance is still such that only the minimum amount of equipment may be supported at the remote terminal, and in general this is consistent with the requirement for low initial cost of the equipment.

Conventional carrier telephone systems for main trunk lines are based on modulation of the amplitude of a carrier-frequency current by the voice-frequency signal. This process produces two sidebands, one of which is normally transmitted, the other sideband and the carrier frequency itself being suppressed and the carrier frequency reproduced by another oscillator at the receiving end. By this means one speech circuit can be provided for every 4 kc/s of available spectrum in each direction of transmission.

This method of modulation requires relatively expensive filters to suppress the unwanted sidebands, and carrier frequencies of high accuracy and stability are essential. On long systems the cost of the filters is small in comparison with that of providing the larger bandwidth which would be needed to permit the use of simpler filters. Furthermore the cost of oscillators is relatively unimportant where large numbers of circuits terminating at the same station share this cost.

In rural systems, because of the short distances and small number of circuits, the same two economic considerations tend to lead to the opposite conclusions, and it becomes necessary to find methods of transmission which require simpler filters and oscillators. Of the methods which have been used or proposed to suit given conditions, transmitting the carrier and both sidebands is the one which reduces the filter and oscillator problems to their simplest.

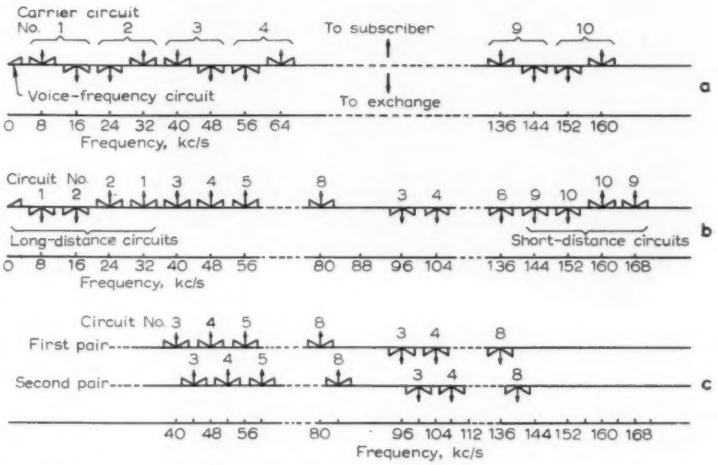
Cost and complexity of the equipment decrease as the bandwidth occupied increases, and for a given set of conditions there is an optimum bandwidth. If line lengths increase or cost of line construction rises this optimum bandwidth decreases and vice versa.

The system designed by the Bell Telephone Laboratories[1] for conditions in the United States employs separation of 12 kc/s between adjacent carrier frequencies whereas a system employing a separation of 8 kc/s has been designed[2] to provide more circuits over longer distances to suit the conditions in such countries as South Africa.

Other methods of modulation have been considered of which the most important is frequency modulation, but although this has some advantages it generally leads to a more expensive equipment. Most current designs of rural carrier system therefore are based on amplitude modulation with the transmission of carrier frequency and both sidebands.

Frequency allocations and numbers of channels

Attenuation of lines and crosstalk between pairs of wires both increase with frequency; these two factors limit the maximum frequency and therefore the number of circuits which can be obtained without resorting to the use of repeaters. The same considerations require that for maximum utilization of wires the same pair of conductors should be used for both directions of transmission with a separate carrier frequency for each.


Carrier circuit No. 1
2
3
4
To subscriber
9
10
Voice-frequency circuit
To exchange
a
0 8 16 24 32 40 48 56 64
136 144 152 160
Frequency, kc/s
Circuit No. 2 1 3 4 5 8 3 4 8 9 10 10 9
Long-distance circuits
Short-distance circuits
b
0 8 16 24 32 40 48 56 80 88 96 104 136 144 152 160 168
Frequency, kc/s
Circuit No. 3 4 5 8 3 4 8
First pair
3 4 5 8 3 4 8
Second pair
c
40 48 56 80 96 104 112 136 144 152 160 168
Frequency, kc/s

2 *Typical frequency allocations*

a Allocation for dropping individual circuits
b Arrangement of circuits in groups
c Displacement of carrier frequencies to reduce crosstalk effect

Two-wire transmission also gives greater reliability than four-wire transmission on account of the relatively high fault liability of open-wire lines.

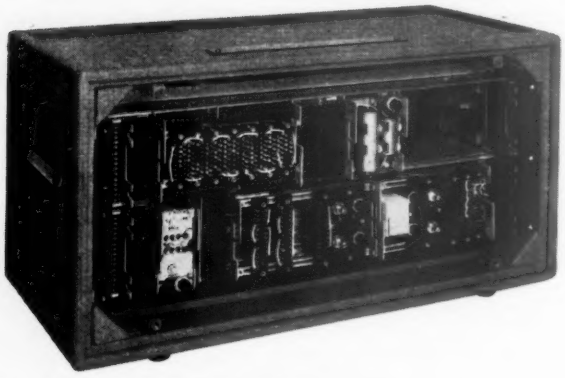
The two carrier frequencies of each circuit may be adjacent to each other or the carrier frequencies for a number of circuits may be separated into groups corresponding to each direction of transmission. The former arrangement is more convenient where circuits have to be dropped individually, and the lower frequencies may be used for longer distances than the higher. The requirements of the filters are more severe in this case, and the arrangement is not suitable if the line attenuation is such as to require the use of repeaters.

Both types of frequency allocation are used, and some systems are capable of either arrangement. In deciding which arrangement to use it is also necessary to consider the frequency allocations of any other carrier systems which may be in use on pairs of conductors on the same poles.

Crosstalk considerations make it desirable that signals of the same frequency on different pairs should be transmitted in the same direction. The upper frequency limit for a system without repeaters tends to be about 180 kc/s as far as attenuation is concerned, which makes it possible to obtain up to ten carrier circuits in addition

to the voice-frequency circuit. Fig. 2 shows typical frequency allocations for such a system.

Crosstalk however sets a very much lower frequency limit except where lines have been specially constructed to give tolerable crosstalk at high frequencies. The expense of line reconstruction cannot normally be contemplated, and for this reason compandors are



3 *A one-circuit terminal equipment*

widely used in rural carrier systems. A compandor is a variable-gain device controlled by the voice signals in such a way as to give an effective reduction in the level of crosstalk and noise, normally[3] by about 20dB.

The compandor may be optional or may be an integral feature of the system, when advantage may be taken of its properties to reduce the requirements of filters and other apparatus. Some additional crosstalk advantage may be obtained in certain cases by displacing the carrier frequencies on different pairs of conductors as shown in Fig. 2c.

Level regulation

It is necessary to compensate for the large variation in attenuation of open-wire lines at carrier frequencies which occurs with varying climatic conditions; this may be conveniently performed by causing the level of the incoming carrier frequency to control the gain of the receiving circuit.

Signalling

An essential accompaniment to the transmission of voice signals is the transmission of the information necessary to select and call the appropriate subscriber and to supervise the call. The actual signals required for this purpose depend on the type of exchange and on the outstation. Functions to be performed range from a simple ringing between a manual magneto exchange and subscriber to the selective calling of a number of parties sharing a common carrier circuit on a fully automatic exchange.

Where a signal is required this may be transmitted by modulating a single frequency; the simplest example of this is the interruption of the carrier frequency itself. More signals may be obtained by controlling the number and timing of such interruptions, by providing additional signalling frequencies, or by a combination of both methods.

Most conditions except selective calling are being dealt with in practice by interruption of the carrier frequency; appropriate relay circuits convert the exchange signals to a form suitable for this purpose. Selective calling has been provided by the use of additional frequencies which since they are required in one direction only do not unduly complicate the subscriber terminal.[1]

As the carrier frequency performs three separate functions special attention has had to be paid in the design of these systems to the avoidance of undesirable reactions between these functions.

Mechanical construction

As there is no special problem in accommodating the central terminal in a telephone exchange, normal rack-mounted equipment is used. At remote terminals however suitable building accommodation is frequently not available, and in such cases apparatus must be mounted in some form of weatherproof housing, such as a cabinet, which may be mounted by the roadside or on a wall or telegraph pole.

Fig. 3 shows a typical equipment for a single-circuit terminal.

Further development

What has been done so far must be considered as a beginning which should be followed by a period of experience and improvement. It is unlikely that any new techniques will make an entirely new approach to this problem worth while in the near future, but it is necessary to continue development in order to reduce costs and extend the field of application of carrier systems in rural areas.

Equipment for subscribers' terminals must be made to consume less power and to occupy less space as improved components become available. More attention must be paid to signalling methods and apparatus associated with the carrier systems. The over-all economics might be substantially improved for example by the use of special subscribers' telephone sets.

Experience has shown that the requirements of circuits between two rural exchanges and those of circuits between an exchange and subscribers cannot always be met satisfactorily by one design of system. Further adaptation is needed to deal adequately with the former type of circuits.

Systems must also be made suitable for the more concentrated telephone networks such as those of the United Kingdom. In such networks a proportion of rural circuits is provided by underground cables; these present somewhat different problems from those of

open-wire lines, and it is in this field that new techniques may eventually find application.

Summary

Carrier telephone systems are used on a small scale as one of the methods of obtaining more circuits to rural exchanges and subscribers. The advent of the transistor has recently made it possible to increase the field of application considerably by reducing to manageable proportions the problem of providing a reliable power supply to equipment in remote locations.

Economic studies of the comparatively low traffic density and short distances involved have led to the adoption of double-sideband transmission, and up to ten carrier circuits may be obtained over one pair of open-wire line conductors.

It is anticipated that further development will lead to much wider application of carrier systems in rural areas.

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NEW ATOMIC ENERGY ESTABLISHMENT AT WINFRITH

THE new U.K.A.E.A. Atomic Energy Establishment on Winfrith Heath, Dorset, opened its doors on the 7th July 1959 to show the progress made since site construction work began in September 1957.

Essentially an extension of the Authority's first establishment at Harwell, Winfrith is being built to enable men to examine new ideas and provide basic design data for application to power generation including work on system feasibility, basic reactor physics, corrosion, control, instrumentation, heat and mass transfer and the effects of irradiation on new materials. It is not proposed to transfer there any of the teams working on thermonuclear fusion so Winfrith will be a fission establishment.

Zenith

The 700-acre site is laid out to accommodate six full-scale reactor experiments if required, although it seems unlikely that more than three will be active at any one time. The first project is the Zenith reactor—a high-temperature gas-cooled zero-energy engineering study. This is a new departure, for previous zero-energy investigations have been at room temperature; because the extrapolation required for high-temperature working is unacceptable Zenith will perform at 800°C and thus provide much valuable information on the use of cores at this temperature.

Zenith is in many respects similar to the advanced gas-cooled reactor described in the December 1958 *Journal* (p. 595) by Dr. J. V. Dunworth, who has become Deputy Director at Winfrith, but will operate at nearly twice the temperature—and of course at zero energy. The core comprises 235 rods of enriched-uranium fuel covered in a recently developed highly impermeable form of graphite. A ring of 30 boron-carbide control rods surrounds the core, and a 3ft-thick annulus of graphite blocks forms the reflector. The reactor will develop about 100 watts.

At the base of the core is a 250kW heater which will heat to 800°C a stream of pure nitrogen; at the top of the core this stream will be mixed with cold gas to reduce its temperature to 400°C and will then be passed down through the reflector to purifying and recirculating plant. Divergence is expected in the early autumn, and the experimental programme can then begin.

Dragon

Lagging Zenith by several months is the Dragon project, an international investigation to be carried out jointly by 12 O.E.E.C. countries—Austria, Belgium, Denmark, France, Italy, Luxembourg, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom and Western Germany. Under a five-year agreement beginning on the 1st April 1959 these countries have agreed to participation in studies and research in connection with the high-temperature gas-cooled reactor system and in the possible design, construction and operation of a reactor experiment.

The proposed reactor will be fuelled with enriched uranium in impermeable-graphite cans, with a core temperature of 800°C and a helium coolant. Since the graphite is not perfectly impermeable provision is made for the helium to leak into the fuel-element can and return to the circuit via a fission-product trap. The staff needed for Dragon will be seconded from the participating countries as required, and it is intended to use facilities available in these countries as much as possible for tests which need not be carried out on site.

The calculations involved in such undertakings as Zenith and Dragon are complex and extensive; a large number of reasonably accurate behaviour predictions are needed before construction of a reactor can begin, and many more calculations are needed to assess the experimental results. It is thus not surprising to find that one of the first major items of equipment in action was a computer, the unit selected being a commercially available network analogue machine with digital input and output. A useful feature here is the detachable patching boards by means of which one problem may be set up while another is in the process of solution.

This is the beginning of a new establishment. There is a long way to go before it becomes fully operational; but under the energetic guidance of its Director, Mr. D. W. Fry, and with the advantages conferred by 'tailor-made' buildings and services (instead of those adapted from Service needs) it may well eclipse the noon-day sun of Harwell.

Numerical control of machine tools

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The numerically controlled machine tool is rapidly acquiring importance in prototype and small-batch production. It has great advantages as a means of saving time, money and space while producing more consistent and often more accurate work. This article describes a system which uses an analogue position-command signal and an analogue position-feedback signal. Mr Puckle who is with E.M.I. Electronics Ltd. opened a discussion on 'Electrical control of machine motion' at the meeting of the Cambridge Electronics and Communications Group on the 13th February 1959.

O. S. PUCKLE, M.B.E., MEMBER

THE advent of numerical control for machine tools, in which control information is passed to the tool in coded form on a punched paper tape or cards, has introduced changes in the philosophy relating to methods of metal removal and indeed the removal of other materials such as wood. It has reduced the cost of prototypes and of small-batch production just as highly mechanized special-purpose machine tools and transfer machines have done for quantity production. Its use greatly speeds the work and increases the consistency of repetition parts besides providing many other tangible and intangible advantages.

Messrs. R. E. Spencer and R. H. Booth invented the system of machine-tool control described herein.

Methods of operating a machine tool

The operation of a machine tool involves two separate functions: the insertion of dimensional information relating to the part to be cut, and the management of the machine which involves all aspects of its operation other than moving the workpiece with respect to the cutter. The method of inserting information has passed through three main stages of development.

When a machine tool, for example a milling machine, is operated by hand the operator inserts the dimensional information by moving the hand controls by amounts which are analogues of the required motions in the x and y axes of the machine; but he has to operate each axis separately, leaving the other locked, partly because of his inability to co-ordinate accurately the manual motions required on two axes. To do this he has mentally to translate the digital information from the drawing into analogue form.

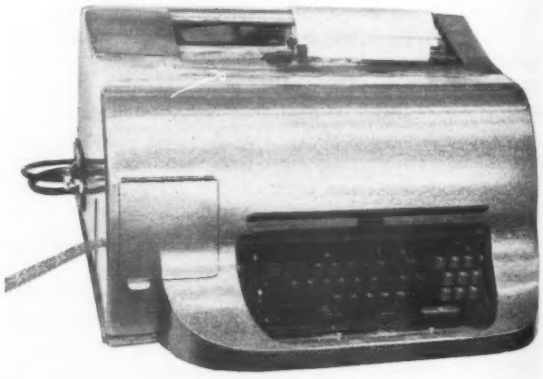
Moreover since his ability to translate digital dimensions into analogue form in terms of rotation of a handwheel is not great enough to enable him to produce a result which is within the required tolerance for the part to be cut, it is necessary to reach the final dimensions by a succession of cuts with measurements of the intermediate results.

Because of the considerable amount of thought needed in the transformation of data from one form to another, the time during which the machine is occupied is very long compared with the actual cutting time. In addition unpredictable errors occur every time a similar part is cut, so that successive parts made to the same drawing show serious inconsistency.

In an attempt to reduce these limitations copying techniques have been introduced resulting in an increased rate of output and improved consistency. There is still considerable waste of time because the templates or masters themselves take a long time to make since they must be accurate. They also have to be fitted to the machine with extreme care, during which time the machine is out of action.

The next logical step is to impart the dimensional information in such a way as to retain the consistency of template control without having to make and fit templates.

This problem has been solved by using tape or cards into which coded dimensional data are punched,



1 *Teletypewriter for encoding data, punching tape and checking accuracy of record*

together with digital/analogue convertors and interpolators to provide a smoothly varying voltage for each axis, these voltages being fed to servo motors or hydraulic servo systems which drive the slides in accordance with the dimensional information.

In addition, devices are provided to measure the actual

position of each slide and to compare this with the required position and remove any error. Obviously it is essential not only to instruct the slides how to move but also to ensure that the instructions are obeyed. Since the instructions take the form of a series of numbers the method is known as numerical control.

Dimensional information

Exactly the same information is required to produce the same contour on a manually operated, a template controlled or a numerically controlled machine, but with the latter most of the information is automatically obtained by interpolation, between selected data points, within the control equipment whereas in the two former cases the whole of the information must be produced by direct human action.

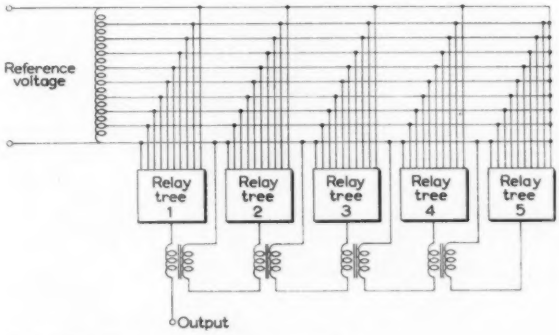
Decimal number	Paper-tape punched code	Typed symbol	Instruction
0	○ ○ ○	0	0
1	○ ○ ●	1	1
2	○ ● ○	2	2
3	○ ● ●	3	3
4	● ○ ○	4	4
5	● ○ ●	5	5
6	● ● ○	6	6
7	● ● ●	7	7
8	● ○ ○	8	8
9	● ○ ●	9	9
10	● ○ ●	S	parabolic start
11	● ○ ●	T	parabolic stop
12	● ● ○	U	linear span
13	● ● ○ ●	V	not allocated
14	● ● ○ ●	not available	
15	● ● ○ ●	not available	
16	● ○ ○	†	stop
17	● ○ ●	B	align control system
18	● ○ ●	C	pause
19	● ○ ●	D	slow speed, interpolator
20	● ● ○	E	fast speed, interpolator
21	● ● ○ ●	F	cutter radius compensation out
22	● ● ●	G	cutter radius compensation in, left
23	● ● ●	H	cutter radius compensation in, right
24	● ● ○	J	backlash correction *x*, in
25	● ● ○ ●	K	backlash correction *x*, out
26	● ● ●	L	backlash correction *y*, in
27	● ● ●	M	backlash correction *y*, out
28	● ● ● ○	N	raise head
29	● ● ● ○	A	lower head to position 1, or accept following head information
30	● ● ● ●	R	lower head to position 2
31	● ● ● ●	*	error

2 *Punching code*

The codes used for punching holes in the paper control tape are shown together with their decimal equivalents, symbols with which they are represented on the teletypewriter, and their meanings associated with the machine-tool system. The small holes in each code have no significance but are used to feed the tape through the tape reader

As a result the information takes a different form. For manual or template control it is in physical form, i.e. rotation of handwheels or provision of templates, and for numerical control it consists of a list of numbers representing the dimensions of salient points on the contour.

The control information is taken from the drawing which is normally made with all dimensions taken from a common datum—a form with which all draughtsmen are familiar. The list is made by a programmer and copied by a typist on a modified teletypewriter (Fig. 1) which automatically punches the tape and provides a typed copy of the programme for checking purposes.



3 *Relay store and analogue convertor*

The decimal binary code is used for punching both dimensional data and management instructions into the paper tape (Fig. 2). The time and effort required to provide the tape are much less than are needed for making a template or for carrying out the various thought processes and check measurements associated with manual operation.

Data-processing equipment

The tape is fitted into a tape reader in a control cabinet set up alongside the machine tool. The information is automatically read, decoded and passed into the stores system, consisting of sealed relays, which retains the information until it is no longer required.

Each store includes an analogue convertor (Fig. 3) for changing the digital information in the store into a variable analogue voltage. Three analogue voltages for three successive data points on each controlled axis of operation of the machine tool are obtained from the stores.

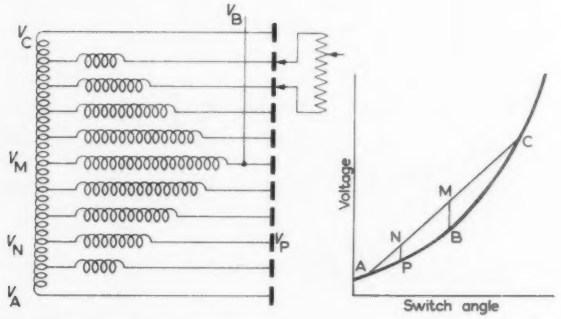
The three voltages for each axis are fed to interpolators, one for each axis. These each have a parabolic stage followed by a linear stage. The outputs of the interpolators consist of separate smoothly varying command voltages, one for each machine axis, and these together represent the required motion of the work past the cutter.

A reference voltage of 1 kc/s is applied to a toroidal auto-transformer having ten equally spaced taps connected to ten busbars (Fig. 3). The voltage across adjacent busbars is nominally 1 volt, and the ratio can be held to within one part in 10^5 by careful manufacture of the auto-transformer.

Each store includes five relay 'trees', each of which

handles one of the five significant digits of information for a data point. Each relay tree selects the busbar whose voltage has the same numerical value as the digit, and since each tree save the first is connected via a 10/1 step-down transformer each digit is given its proper significance. Because the same reference voltage is used elsewhere the voltage and frequency can vary within wide limits without ill effects.

Three similar sets of stores and analogue convertors deal with three successive data points for the x-axis and



4 *The interpolator*

a similar set for three on the y-axis, and these are passed respectively to the x and y interpolators. Since data for a further two data points must be available before the cutter reaches the end of a span of three, it becomes necessary to provide five stores and five analogue convertors per axis.

If the z or vertical axis of the machine tool is also continuously controlled a third set of five stores and convertors and an interpolator have to be provided. If however the z-axis is intermittently controlled it needs only two stores and two convertors but no interpolator. If an automatic clamp is provided for holding the z slide in position only one store and one convertor are required.

The three analogue voltages V_A, V_B and V_C relating to successive data points of one axis are denoted by A, B and C on the curve in Fig. 4. If V_A and V_C are applied to the ends of a toroidal auto-transformer the voltages at the taps will lie on the chord ANMC shown on the curve. A toroidal transformer having 22 secondary windings in two groups of 11, not all of which are shown, is also used, the numbers of secondary-winding turns being parabolically related.

If now V_B is connected as shown a voltage represented by MB will appear across the primary winding. Twenty-three voltages such as are represented by NP and MB are added to the potentials at the auto-transformer taps and define the curve APBC. These voltages will appear on the contacts of a uniselector.

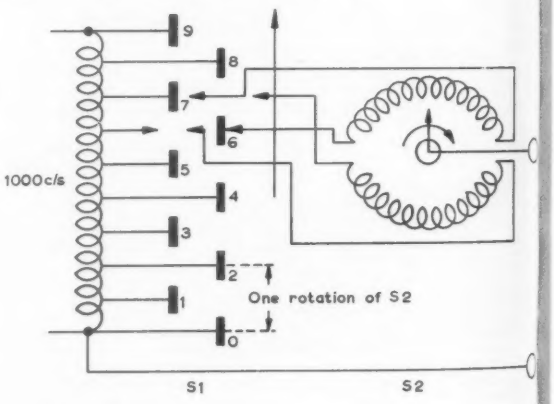
Linear interpolations between the 25 voltages along the curve APBC may be carried out by means of a resistive potentiometer whose slider moves along its length while its input contacts move from one pair of studs to the next on the uniselector of the parabolic stage. The voltage appearing at the slider will then provide linear interpolation between each of the parabolically interpolated steps.

In practice a resistive potentiometer is not satisfactory because it introduces phase changes, and two further toroids are used instead. In Fig. 5 the whole of the parabolic stage except the contacts of the switch S1 has been omitted, but the contacts S2 for the linear stage are indicated in the circular arrangement which they assume in practice.

The 'parabolic' uniselector and the 'linear' rotary switch are driven at different speeds, one complete revolution of the linear switch S2 taking place while the parabolic switch S1 rotates through two contacts so that the two toroids are used in 'leapfrog' fashion to avoid switching discontinuities. Switch S2 moves over a total of 128 contacts, 64 for each toroid, which therefore provide 64 linearly interpolated steps between each of the 24 parabolic steps or 768 per adjacent pair of input data points. An ingenious circuit modification can annul even these minute voltage steps.

Spans

Data from the tape are passed into the stores in sequence by another uniselector which also stops the reader when sufficient data are read. The reader starts under control of the 'parabolic' uniselector controlled by the motor-driven 'linear' rotary switch. If the motor speed is unchanged the time taken for cutting a span of three data points is constant.



5 *Linear interpolator*

Since more information is required to define a curve than a straight line curved spans tend to be shorter than straight ones. Maintaining accuracy on curves of small radius together with a reasonable feed-rate on straight paths results in variation of the cutting velocity when changing from a curve to a straight line. This change

can be made gradually by moving the intermediate or minor data point of a straight span by an appropriate amount from the midway position. The average feed-rate can be adjusted by controlling the speed of the motor which drives the linear rotary switch.

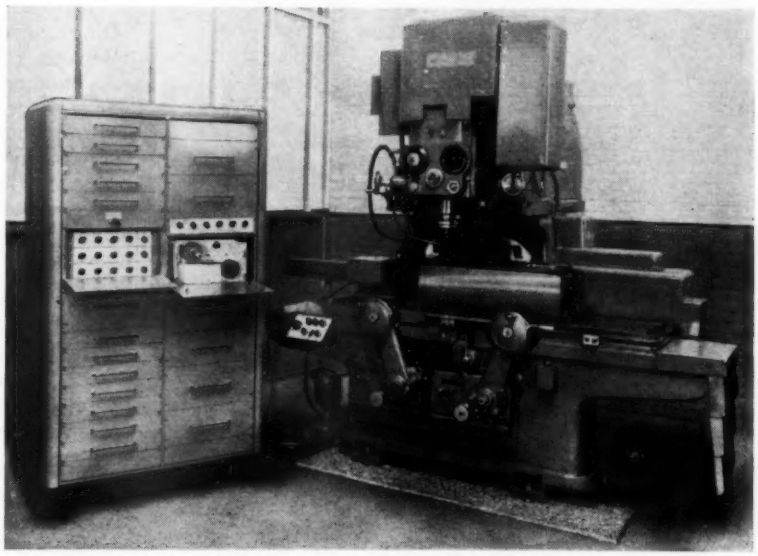
Position control

All position servo systems require that the achieved position be measured and compared with the desired one. In the present system the comparison is made by means of a differencing unit which causes the slide to move only when the achieved and desired positions are unequal. However, motion of the slide must result from an extremely small difference of position, so that amplification of the error signal is required. Amplification of the error signal involves the use of an analogue negative-feedback loop for each axis of slide motion.

The differencing unit whose input consists of the feedback signal representing actual position and the command signal representing the desired position of the slide provides the error signal to drive the servo motor in the appropriate sense to reduce the positional error to zero (Fig. 6). A tacho-generator feedback loop (not shown) is also fitted to ensure stability of the servo system.

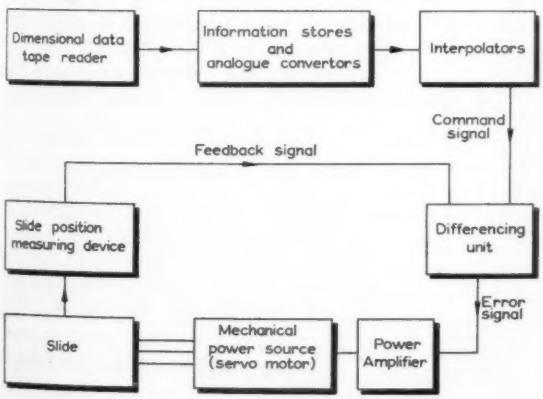
A number of methods of measuring slide position which provide different degrees of accuracy are available, their cost bearing some relation to the quality of the result. There is considerable advantage in being able to provide cheaper control systems for those who require less accuracy. In this case the measurement of the actual slide position is replaced by a measurement of leadscrew rotation; but this provides no compensation for leadscrew errors or backlash although it remains possible to measure these errors and to make allowance for them when writing the programme.

When more accurate work is required the actual slide position is measured; one such instrument for example has a setting accuracy of 10^{-4}in. The leadscrew and backlash error can then be included within the feedback loop. However certain distortions of the machine tool, cutter deflection and the effect of the presence of swarf still remain outside the loop, and no one has yet found a satisfactory means of measuring the dimensions at the point where the cutter touches the work.



7 *Hydraulic milling machine with control cabinet*

The tape-reader is on the right of the cabinet with the cutter-diameter compensation unit above it. The datum-shift unit having one row of control knobs for each of the three machine axes is on the left. The starter panel with the feed-rate control knob is mounted at the left-hand end of the bed of the machine tool



6 *Control system for one axis showing feedback arrangement*

Three-dimensional control

Three-dimensional systems (Fig. 7) cost more than two-dimensional, and a compromise system provides continuous control of two axes and intermittent control of a third (Fig. 8). This type meets a wide need since it can also cater for most diesinking work. A manually operated switch permits the intermittent control to function on any one axis.

Additional facilities

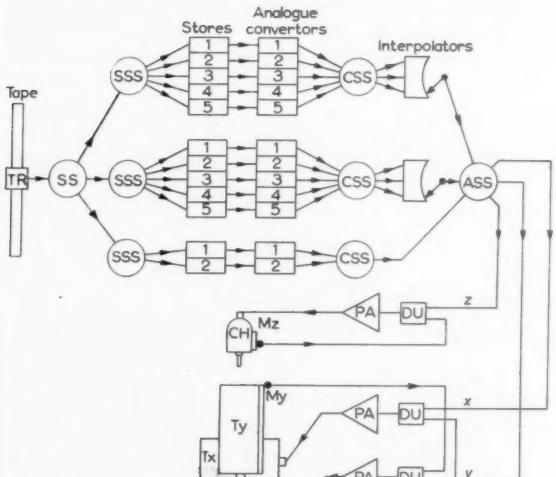
It is possible to use cutters of radii different from that envisaged when the tape programme was written. The cutter is moved automatically in a direction always

normal to the contour being cut and to an extent determined by the setting of knobs on the control cabinet, for example a maximum of 0·3in. in steps of 10^{-4}in. By this means reground cutters can be compensated for, final light cuts made for greater accuracy and better surface finish, and rebates and mating parts made from the original tape.

The datum point on the machine-tool table can be off-set, normally up to a maximum of 10in. in steps of 10^{-3}in. in any of the three axes.

Dimensional information can be supplied to a machine tool within $\pm 10^{-4}$in. for a 10in. or 10^{-3}in. for a 100in. table, but there is also a device which permits the use of a table of any length without increasing the basic tolerance.

Mirror images can be made from the same tape by rotating a knob on the machine tool. This causes the servo motor to run in the reverse direction and the measurement of table position to start from the opposite end and proceed in reverse on one axis only.



8 (above) *Block schematic for a controlled machine tool*

Continuous control can be applied to two axes and intermittent control to a selected one

TR	Tape reader
SS	Sequence switch
SSS	Stores selector switches
CSS	Convertor selector switches
ASS	Axis selector switch
DU	Differencing unit
PA	Power amplifier
CH	Cutter head
Tx, Ty	X and Y slides
Mx, My, Mz	Position-measuring devices

Time saving and reliability

The time saved by using a numerically controlled machine tool means that from five to 25 parts can usually be made in the time normally required to make one by manual methods, and when the programme tape has been checked the elimination of human fallibility results in much more accurate and consistent production.

Other controlled machines

When it is required to move a slide or rotate a table from one position to another, the intermediate route being of no importance, there is no need for an interpolator.

Linear-table positioning systems are available (Fig. 9) which can provide an accuracy within $\pm 2 \times 10^{-4}$in., and the whole process of drilling a number of holes and switching off is entirely automatic. A rotary table accurate to within ± 3 seconds of arc (Fig. 10) can be used for marking out or for positioning a part which is to be cut. Alternatively it can be fitted to the table of a milling machine and controlled by the same tape so that contouring in polar co-ordinates may be carried out.

The control system can also be applied to lathes, boring machines, flame cutters, measuring tools, etc.

Advantages of numerical control

Numerical control permits spare parts to be made as and when required instead of large stocks having to be kept. Shipping costs, delays and damage can be avoided by transmitting the

9 *Linear positioning table with control cabinet*

Dimensions can be set up on knobs or read from a tape

programme by teletypewriter, which automatically punches the tape, to the place where the spares are required.

If parts become damaged after manufacture or if the material is found to be faulty the cost of and delay in replacement are reduced. The accuracy cuts down the need to inspect repetition parts.

There is less limitation in the shape of parts which can be cut since the slides can move simultaneously.

The reduction in manufacturing time means that designs can be more adequately proved before production commences. Jigs and templates needed for mass production and inspection can be quickly and accurately made.

Summary

There is a promising future for the numerical analogue position control of machine tools in speeding up work, increasing accuracy and reducing direct and indirect costs in the light and heavy engineering industries and in the woodworking industry.

10 *Rotary positioning table with cabinet for setting up instructions in degrees, minutes and seconds*

Supply-industry university scholarships

THE first successful candidates in the new scholarship scheme sponsored by the electricity supply industry in England and Wales will be going up to university during the next week or two. In this scheme, which was introduced in autumn 1958 to help meet the industry's need for highly trained scientists and engineers, sixth-formers intending to read for degrees in science and engineering were invited to apply for scholarships worth £450 per annum at Oxford and Cambridge and £400 at other universities.

About 350 replies were received, and after interviews 45 scholarships were awarded, 19 by the Central Electricity Generating Board who require both scientists and engineers and 26 by the 12 area boards who require electrical engineers only.

In return scholars have to agree to two main conditions. They are expected to spend a period of training with the industry—possibly as little as six weeks—before going up to university, and after obtaining their degrees they are required to work in the industry for at least two years.

To be an engineer

IN a recently published booklet in their 'Choice of careers' series* the Central Youth Employment Executive review the opportunities for boys as professional engineers. The training of a professional engineer these days, it is stressed, is planned to equip him to apply a scientific outlook to the analysis of problems, design of machinery, process development, and management. Methods of obtaining academic qualifications and early practical experience are described, and a general idea is given of the relationship between the usual examinations and the requirements for membership of the professional institutions.

Although a chapter is devoted to the nature of work in the various departments within an organization, such as research, development, and production planning, it is pointed out that a choice of this sort need not be made until some years after starting the training.

What is more important, the Executive say, is choosing, at the time of deciding whether or not to take chemistry in the sixth form, which of the main divisions of engineering would offer the greatest interest and satisfaction. Brief notes are given on the main branches of engineering and on certain aspects of some more specialized kinds.

Case-histories are then quoted for a young electrical engineer in charge of design of power transformers, a production manager in an aircraft-engine firm, and two local-authority engineers.

* Choice of careers No. 92 'Professional Engineers', H.M.S.O., London, 1959. 1s. 6d.

Orrin hydro-electric station

THE Orrin, Ross-shire, power station of the North of Scotland Hydro-Electric Board which is now in commercial use contains one 18 MW machine operating under a gross head of 728 ft. Its estimated annual average output of 76 million kWh is fed into the 132 kV Highland Grid.

The building is situated on the shore of Loch Achonokie, the reservoir formed by the Board's Torr Achilty dam. The Orrin scheme demanded the construction of two dams in Glen Orrin to form a 5-mile-long reservoir with a storage capacity of 2000 million ft^3 of water. In addition to a concrete-lined pressure tunnel 3¼ miles long and a steel pipeline leading down to the new station, 6 miles of concrete-pipe aqueducts had to be constructed to collect water from adjacent rivers. In all, the catchment area utilized by the Orrin scheme amounts to 54 square miles.

The disturbance to fish caused by the variation in reservoir levels has been minimized by the incorporation within the dam of a specially designed Borland fish-pass.

The Institution in Yorkshire

Some impressions of the 1959 Summer Meeting, 15th–19th June

It is difficult to avoid superlatives about what was one of the most outstanding Summer Meetings in The Institution's history. The 415 members and ladies who took part would acknowledge that the careful planning by the North Midland Centre officers and the friendliness and hospitality of their Yorkshire hosts made the week altogether memorable. The programme had been well arranged almost to the last second so that there was no time to be bored while the week's events, seen against the background of the beautiful countryside, flashed by. Everything lived up to the splendid occasion. The sun shone from almost uniformly blue skies, and yet there was often enough a coolish breeze for refreshment.

The Royal Hall in Harrogate was the setting on Monday evening, 15th June, for the civic reception by the Mayor of Harrogate. The hall is a true palace of variety ranging from symphony concerts to all-in wrestling. On this night, with 'The Institution of Electrical Engineers' displayed along the fascia of the entrance, it saw a long queue of members and their ladies waiting to be received by the Mayor, Councillor G. H. Holroyd, and the Mayoress and by the President of The Institution and Mrs. Goodall on the main floor of the hall which was later the scene of dancing.

Around and about Leeds

Thirteen alternative all-day combined visits and excursions had been arranged for Tuesday. They were all within striking distance of Harrogate and most within the Leeds area. The firms visited were Crompton Parkinson, English Electric, John Foster, R. W. Crabtree, Yorkshire Electric Transformer, Yorkshire Switchgear and Engineering, Mains Radio Gramophones, Joshua Tetley, Montague Burton, Hunslet Engine, Listers, John Waddington, and Joseph Watson. The social contrast was provided by Wharfedale, Haworth and Lothersdale, Fountains Abbey, Emley Moor and Harewood House.

Those who chose R. W. Crabtree, Leeds, and Fountains Abbey found that Crabtree make mainly two kinds of printing machine: the high-speed newspaper and magazine rotary and the offset litho. A couple of large newspaper rotaries for export to the Commonwealth were standing in the main erection department.

After luncheon at Roundhay, Leeds, which started in the proper way with Yorkshire pudding the party turned back towards Fountains Abbey. Ample notes had been provided so the visitors could identify every point of note in Fountains Hall and in the Abbey.

In its state of preservation and peaceful disposition in the gentle valley of the river Skell the Abbey remains a grand and forlorn memorial of its erstwhile inhabitants. The cellarium is worthy of particular mention. Three hundred feet long and divided down the middle by pillars it has a floor thickly inlaid with the silt of centuries. In the cool semi-darkness the authentic presence of the monastery is close at hand.

A walk along the Skell and past a fine yew hedge brought the party to a lake and a restaurant. After tea they returned to Harrogate in time for dinner before the reception at Leeds University.

The guests were received in the court of the Parkinson Building by the Pro-Chancellor, Brig. J. N. Tetley, and the Vice-Chancellor, Sir Charles R. Morris, and Lady Morris. The University had arranged a variety of events. Those early enough to obtain a seat were entertained by the Leeds Guild of Singers and by a recital on the virginals. Another crowded room was in the phonetics department where recordings were played of English dialect and speech.

In the Brotherton Library were books and documents of scientific worth, including works and manuscripts by Ampère, Volta, Faraday, Kelvin, and Clerk Maxwell. There was a first edition of Newton's 'Philosophiae naturalis principia mathematica' dated 1687 and bearing the *imprimatur* of Samuel Pepys in his capacity as President of the Royal Society in 1686.

Further afield

Some of the parties left the confines of Yorkshire on Wednesday, for which 12 visits had been arranged covering greater distances than before. Sheffield concerns visited were Metropolitan-Vickers, B.I.S.R.A., James Neill, Darwins, Swift Levick, English Steel, Thomas Firth and John Brown, Mappin and Webb, and Walker and Hall. The Derbyshire relief was provided by Haddon Hall and Chatsworth House. There was a full-day works visit to Steel, Peech and Tozer, Rotherham, for enthusiasts, and for non-enthusiasts a full-day tour via York and Bridlington to Scarborough returning via Whitby, Helmsley, Thirsk and Ripon.

In spite of a gloomy forecast the weather was fine as one of the parties for Chatsworth passed through smiling country until the approach (here the smile changed to a slightly puzzled frown) to Barnsley and Sheffield. Chatsworth, 'The Palace of the Peak', has a not-too-unfortunate exterior; and its interior though mixed is in parts grand, in others pretty, and throughout genuine.

The 'loadstones' of James Neill attracted the party in the afternoon. After lunch in the canteen small groups saw first in the demonstration room the power and versatility of these steel and alloy permanent magnets. Shell moulding is mostly used for manufacture though sand moulding is still carried on.

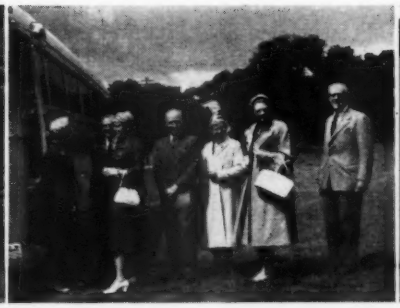
The magnets are every size and shape including some which look like curtain rings for picture adjustment in television tubes. The dexterity of the gaugers was impressive. With a magnet in each hand one woman was carrying out eight operations in a matter of seconds. After tea the party returned to Harrogate and to a free evening.

From Holme to Hull

Thursday saw parties departing for nine excursions over a wide area. Mornings were spent at J. Blakeborough, B.B.C. Television Holme Moss, Brook Motors, Wakefield 'B' power station, E. Green, Hopkinsons, Rowntrees, Wormalds and Walker, or Hull Docks, and afternoons touring Haworth and Lothersdale or via Boroughbridge and Byland Abbey or York or visiting Temple Newsam, Nostell Priory or Blackburn Aircraft.

The coach for Hull started in dull weather which had returned to normal brightness by 10 o'clock at York. It drove past York Minster with its surrounding scaffolding and on

Harewood: Mrs. Caton, Mrs. Goodall, Mrs. Rylands

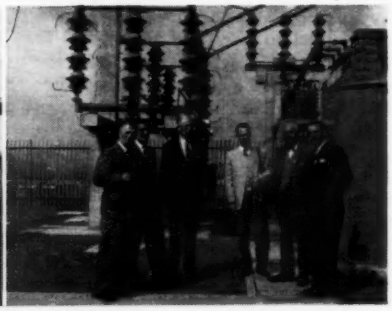


Coach and party at Harewood

Weld-watching at Yorkshire Switchgear

Sir Willis Jackson at the departure point

Visitors with Beverley



Seeing Silsden substation

Mr. Nicholson on a busman's holiday at Silsden

The President in a tactical wireless group

A message from Nairobi

Admiring civic plate at Richmond

A 'stick' of paratroops at Catterick

Applause for the cabaret

through the Yorkshire plain to Beverley, once the capital of the East Riding. A curiosity here is that the buses have a ridge top to enable them to pass through the Bar Gate. The Minster contains the tomb of St. John of Beverley who died in 721 and a sanctuary chair given by Althelstan in 937.

At noon the coach began its tour of Hull docks, practically deserted because of a dockers' strike. Grain and coal are the chief materials handled, and in the King George Dock the party saw the enormous grain silo which helped Hull to regain its 'third port' status.

Lunch at Hull Guildhall was at the invitation of the Telephones Committee of the Corporation, and in the anteroom beforehand visitors tested the special services of the municipal telephone department. One can dial for the cricket score, the weather, the time, the cinema programme, the latest popular record and even for advice on what to cook.

The dignity of a civic occasion surrounded the luncheon, the Sheriff and his lady, the Lady Mayoress, and the chairman of the function (the Chairman of the Telephones Committee, Councillor R. E. Tennyson) entering the banqueting chamber severally after due announcement. After a fine meal prepared by the Corporation's catering department Councillor Tennyson said that he felt a kinship with members of The Institution because he was the son of a postmistress and had been associated with Hull's telephone service since 1914. The Chairman of the North Midland Centre, Mr. J. D. Nicholson, expressed thanks to all their hosts in Hull.

The coach then traversed the new Riverside Quay whence passenger ships ply to Rotterdam and Hamburg. At the Albert Dock rows of tractors awaiting export were to be seen and at St. Andrew's Dock the high buildings which are used for smoking herring. A last view of the city included a lorry laden with boxes labelled 'please return to Hull', an invitation which the party were in a good frame of mind to accept.

At Brough the coach travelled onto the airfield where Blackburn Aircraft build their Beverley transport plane. The party clambered aboard one of these vast machines and were soon engaged in climbing ladders, peering through portholes, inspecting the pilot's compartment, and generally expressing amazement at the size of the load-carrying compartment. One of its feats has been to transport a 24-ton mechanical shovel to an airstrip at Hudson Bay. The coach returned via Selby and Tadcaster, cows crossing Spofforth Bridge being partially responsible for the late return at 6 p.m.

The Institution dinner and dance took place in the evening at the Hotel Majestic, Harrogate. The President expressed the gratitude of the whole assembly to the North Midland Centre. He particularly mentioned Mr. Nicholson and Mr. H. A. Carr as well as the Honorary Assistant Secretaries for the meeting, Mr. J. F. Cunningham and Mr. R. Spence.

The Mayor said that whereas 29 years ago Harrogate had been the Mecca of the aged it was today one of the main conference towns of the country. Mr. Nicholson in proposing the toast of the guests referred to earlier doubts whether the visits were not too many and in some cases too distant. The Centre had stuck to their guns, and he thought they had been vindicated in the event. In reply Prof. J. T. Whetton on behalf of Prof. G. W. Carter gave some details of the electrical engineering department at Leeds University.

After dinner dancing in the ballroom continued until 1 a.m.

Mainly military

Friday, another day of perfect weather, was devoted to nine excursions. One was to the School of Signals, Catterick Camp, followed in the afternoon by an outdoor display by units of the garrison. The afternoon show was seen also by two parties who had in the morning visited the Yorkshire Electricity Board substation at Silsden near Keighley, and been the guests of the North Eastern Electricity Board on a tour of Wensleydale and Richmond respectively. Companies visited by other parties were Appleby-Frodingham Steel, Samuel Fox, Shepcote Lane Rolling Mills, Glass Bulbs, Joseph Terry, Birkby's, and Pilkington's; with meanderings through York, Keighley and Bolton Abbey, and Doncaster and Pontefract.

The journey to the School of Signals in the morning passed Nidderdale, Jervaulx Abbey, Wensleydale and Leyburn (crossing the river Ure for the third time) before reaching Catterick Camp, that moorland enclave of almost monastic austerity. At the Royal Signals Headquarters Mess the guests were welcomed by Brig. R. G. Yolland, the Commandant of the school.

The visit had been prepared for on the lines of a military operation. Six demonstrations of 15 minutes each, with five minutes for the journey from one to the next, gave the visitors a view of the work of the school covering 'basics' (elementary to advanced theory), high-power wireless, aerials, line/radio relay equipment, and tactical wireless. While being shown the high-power wireless some guests accepted the invitation to offer messages for transmission to Nairobi where members were available to exchange signals.

The visitors saw the new light field cable which is rolled on 'dispensers'—small reels in which the wire is paid out from the centre. Gone apparently are the weird cable-laying machines which could be relied on to defy starting at some critical moment. The emphasis in the school's teaching methods is on simple, practical, objective work moving through steps of calculated drill to advanced communication concepts. Lunch was taken in the Headquarters Mess.

At the display ground after a trumpet fanfare Brig. Yolland set the ball rolling with the immortal words of Sam Small at Waterloo 'Let battle commence'. A squad of physical-training instructors opened with a demonstration of precision gymnastics. In the line-laying race that followed a party of Regular linemen beat a team of National Servicemen. Next there was a silent drill display by a squad of junior n.c.o.'s.

An Auster piloted by a Signals officer seconded to the Army Air Corps demonstrated message and supply drops in the fourth 'turn' on the bill. Lastly a team of four set up a radio relay station operating in the 4580–4860 Mc/s band. Mr. Nicholson gave an order over the link for a sequence of Very lights to be fired by the distant station. The lights were fired, the team drove off, and the visitors adjourned for tea during which they were able to see a static display of signalling equipment and a parachute detachment.

The coach parties drove through Swaledale and arrived in Harrogate with fair time in hand for the supper dance at the Hotel Majestic arranged by Yorkshire Switchgear and Engineering and Yorkshire Electric Transformer. This function was all that had been rumoured and more. The food was delectable and the service excellent. After supper the dancing was interrupted first to give the President the opportunity of expressing thanks to the hosts and of wishing the visitors a safe journey home; and secondly for the cabaret.

At 1 a.m. the dancing ended, final leave-takings were made and the tired guests refreshed themselves with sleep for Saturday's journey home.

Thanks are due to Mr. J. R. Rylands for acting as unofficial official photographer for the meeting.

Automatic control in the Soviet Union

A first impression from the British team

Collaboration between the Council of The Institution and the Soviet Relations Committee of the British Council on the one hand and the Academy of Sciences of the U.S.S.R. on the other resulted in a visit by a British team in the last two weeks of May 1959 to study the developments and applications of automatic-control techniques in industry in the Soviet Union. This reciprocated a visit made to the United Kingdom in November and December 1958 by a Russian team of control specialists.

*The author who is Head of the Department of Electrical Engineering at the Imperial College of Science and Technology and was Leader of the British team gives here some personal impressions of the visit.**

PROF. A. TUSTIN, M.SC., MEMBER

ABOUT a year ago the Academy of Sciences of the Soviet Union proposed an exchange of visits by Soviet and British engineers concerned with automatic control in industry. Six Russian experts led by Prof. B. S. Sotskov visited this country in December 1958, and the British team of experts recently made the return visit.

Experts are said to range from those who know everything about nothing to those who know nothing about everything. The British team included A. J. Young, A. Asbury, S. S. Carlisle, P. H. Hammond and R. H. Tizard who clearly belong to the useful middle band of this spectrum. The writer was perhaps included as contributing a somewhat faded knowledge of the Russian language and some personal experience of the Russia of 25 years ago.

The sap is flowing

The party were in Russia for two weeks, visited Moscow, Leningrad and Kiev, saw research laboratories, factories, colleges and theatres and met a great many people. Assessment will need time for sober reflection and for digestion of the mass of literature and references that the team collected. This note is not a report; it is an attempt to pass on to readers of the *Journal* an immediate personal reaction to two weeks of many-sided new experiences.

My dominant impression both from general observations and from the closer investigation of our special field is one of immense vitality and purposefulness. The symbol comes to my mind of a sturdy tree in early spring; the sap is flowing, the buds are swelling, here and there foliage is just breaking. But what the eye now sees carries the further promise of a coming summer of flowers and fruit.

But enough of poetry. Let us, as becomes scientists, be precise. What is this rising sap? I mean the swarming thousands of keen-looking students we saw in the institutes of higher technical education. What are these swelling buds?

The delegation with Profs. Sotskov, Tsypkin, Letov and others near the Institute of Automatics and Telemechanics

They are the scientific institutes, many of them new ones, packed to bursting point with preparatory activity. And what will be the fruits? Well, the Soviet engineers have no doubts. With an eye of certain faith they see an early future of abundance without excessive toil.

Is such a hope well-founded on a cool and logical assessment of their present achievement? I suppose it is a matter of more or less. We just do not know, for any country, how much promise automation holds. But it seems that its full potential has a greater chance of being achieved in Russia than in most places, first because production in a planned economy can be on a massive scale and for assured periods; and secondly because faith moves mountains, and the Soviet philosophy has for one cornerstone the faith that through science and the intellect men may dominate nature and transform their own life.

Of course we in the West want to qualify this. We say that science and the intellect can never be more than tools, though powerful tools indeed, for implementing purposes and values that spring from non-rational roots in our human nature. The Soviet reply I think would be 'So what!', for the achievement of abundance of means is to them a self-evident good and the indispensable condition for the achievement of all other values. It is in any case a task sufficient for the day.

Technical education more widespread

My impression is that this purpose of exploiting the physical sciences to the utmost is being implemented with a realistic quantitative plan, shown in the first place by the scale and nature of the massive development of technical education. The team went to see technology, not education, but we had occasion to visit some teaching institutions, including the Moscow Power Institute with its 13000 students in training for the electric power industry and the Leningrad Electro-Technical Institute with 6000 electrical engineering students.

* Details of the full report of the British team are given on p. 556.

Applied sciences such as electrical engineering are not taught in the Russian universities. We visited Moscow University (22000 students) and had a glimpse of the teaching of physics. We were told that in the U.S.S.R. in 1958, 266000 students graduated, of whom 83000 were engineers. Comparison by numbers with this country is difficult because of the varied types of training here, but on any basis of computation it is clear that the proportion of the population receiving advanced technical education is much larger than in Britain.

What however of the quality? Their courses are 5 or 5½ years, and we formed an impression of the level achieved by seeing some of the diploma work that normally occupies the concluding six months of the courses. Our small sampling estimate may be misleading, but what we saw of work in progress implied that good use is made of the 5½ years. The laboratory equipment we saw was excellent and the tutorial experiments well conceived.

Research and development work aiming at the application of automatic control in industry is done in 'institutes' of at least three kinds: the teaching institutes where research is done by postgraduate students and staff, the research institutes of the Academy of Sciences concerned in principle with theory and fundamentals, and research institutes under the industrial ministries, whose work is co-ordinated as part of the state economic plan (Gosplan). These are directly concerned with industrial application.

This distinction between the functions of scientific and industrial institutes is however not clear-cut. We found both kinds of institute to be concerned with application, but the institutes of the Academy seem to contribute very considerably to the large output of books and technical papers that is an important component in this vast educational programme.

The Institute of Automatics and Telemechanics in Moscow and other institutes

The central institute of the Academy of Sciences for the study of automatic control is the Institute of Automatics and Telemechanics in Moscow. From this institute came most of the team that visited this country and incidentally spent an evening with the Measurement and Control Section. We were delighted to see again Prof. Sotskov whose personal concern to make our visit both pleasant and profitable was unstinted. We met once more Prof. Tsypkin, as lively as ever, Prof. Il'in, among his telemetering developments, and all the others.

We met Prof. Letov who is organizing the conference of the International Federation of Automatic Control that is to be held in Moscow next year. He looked just a little worried; the hundreds of papers offered from all over the world in many languages have given him quite a problem.

This Institute of Automation and Telemechanics is one only of a network of institutes concerned with industrial control. We found the pattern of these institutes confusing. Perhaps it is clear to the initiated. They have similar-sounding names and are often referred to by initial letters. We asked at the Academy of Sciences for some list or directory of the institutes dealing with industrial control but were not able to obtain one.

We do not know what fraction we saw of the total activity, even in the three towns we visited, still less in the whole of the Union and its satellites. Nevertheless our attempt to establish communication in this field has had some success; we know where many important developments are in progress, and the directors and engineers everywhere expressed their desire to maintain and develop contacts with this country.

A view of Moscow University

A probable lag

But in this note I can attempt only a general assessment, without reference in detail to persons and places. The question that many people will ask is 'How does progress in the Soviet Union in the field of automatic control compare with that in the West?'. This is not easy to answer, but one may mention some relevant facts.

In Britain and the United States the position has been reached in which the control of individual quantities is done where required as a matter of accepted engineering practice. Many innovations are of course being made in devices such as transducers and instruments, but they are rarely innovations in principle. The cutting edge of progress has moved forward to the attempt to solve the more complex problems involved in the control (in a broad sense of the word) of processes, as in the co-ordinated control of chemical plants, rolling mills or power systems.

Although much progress has been made it is not easy in Britain to show many established industrial applications that exemplify such potentialities. But there are many and various experimental installations, often only in the laboratory stage, that promise early maturity.

In the Soviet Union the programme arranged for us comprised visits to only a few factories including a car factory, a carburettor factory, and a fully mechanized section of the very large Moscow ball-bearing factory. In these factories we saw no examples of advanced automatic process control in the above sense. The automatic roller-bearing line is indeed a fine example of the skilful design of automatic mechanisms, but not of process control. The mechanized accountancy of this factory used punched-card machines of the style well

established some years ago. The car factory included transfer machines, but they were not more advanced than one could have seen in England almost a decade ago.

Perhaps for geographical reasons we did not see the most relevant factories, but many inquiries brought us information only about one-off experiments usually still under the control of the research institute fostering them. We heard of experimental boiler controls and of controls for blast furnaces, open-hearth furnaces and so on in this advanced experimental stage. It may be noteworthy that we heard relatively little about process control in the chemical industry beyond well established local instrumentation.

Our conclusion is that, in the use of advanced concepts of control in actual production, the Soviet Union is at present probably lagging behind Britain.

Broad front impressive

On the other hand almost all the possibilities that are at present being examined in England or America appear also to be under investigation in the Soviet Union. In the field of devices we saw work in progress on such things as thin magnetic-film memories and cryotrons. Analogue equipments, both standard-component and special-purpose, are freely used. Digital computers are being made in hundreds, but the designs are on well established lines. We saw active work on automatic language translation and a project for a 'learning mechanism' based on the simulation of neurons. We saw, however, little achievement anywhere that decisively gives a lead into possibilities we were not well aware of, though naturally there was useful novelty in detail and approach.

Nevertheless it was impressive to see active and competent work going on along such a broad front. We were also struck by the rate at which the potential for future progress is being built up. Of the five research institutes we visited that were concerned essentially with control for industry two were only two years old and one three years.

At the Central Institute for Automation of the Ukraine at Kiev which started two years ago and at present deals mainly with automation in the steel industry we were shown plans for new buildings to increase the population of the institute from the present 700 persons to 4000. Building will start in 1960 and will be completed in three to four years. This institute will develop automation in heavy industry, including chemical and metallurgical plants and mines.

It is evident that institutes only two years old can scarcely yet have made their weight felt and that present industrial status is no proper measure of the potential for progress.

A general finding

My personal general conclusion is that we may expect this tree to bear a rich harvest of fruit and that there is a high probability that within the next few years the engineers of the Soviet Union will be giving a decisive lead to the rest of the world in those applications of automatic control and automation in industrial production to which they choose to apply the powerful organization they are so rapidly building up.

Work of C.C.I.R. in Los Angeles

The 9th Plenary Assembly of the Comité Consultatif International Radio (C.C.I.R.) was held at the invitation of the United States Government in Los Angeles from the 2nd to 29th April 1959.

The C.C.I.R., an organ of the International Telecommunications Union (I.T.U.) which is a specialized agency of the United Nations, is concerned with making technical recommendations for the development of radio. Its plenary meetings are held about every three years and since the recent war have taken place in Stockholm (1948), Geneva (1951), London (1953) and Warsaw (1956). The next one will be in New Delhi in 1962.

Its recommendations are of interest to all concerned in telecommunication and particularly to members of the Electronics and Communications Section, several of whom played an active part in the Los Angeles plenary meeting.

United Kingdom delegation

Some 40 countries together with 30 private operating agencies and international scientific and industrial bodies were represented by about 300 delegates at Los Angeles.

The United Kingdom delegation was led by Capt. C. F. Booth of the Post Office, a past-chairman of the Electronics and Communications Section. It included Lt.-Col. A. H. Read, Telecommunications Attaché from the Embassy in Washington; nine delegates from U.K. Government departments including the Engineering Department of the Post Office, the D.S.I.R. (represented by Dr. R. L. Smith-Rose, another past-chairman of the Electronics and Communications Section, and Dr. J. A. Saxton), and the British Joint Communications and Electronics Board; ten representatives of the B.B.C., I.T.A. and other operating agencies and four advisers from the Radio Industry Council.

Work of the meeting

The scope of the meeting was wide, covering the whole field of radiocommunication including point-to-point world-wide telegraphy and telephony systems on long, medium and short waves; sound and vision broadcasting; tropospheric and ionospheric propagation; microwave relay systems for multichannel telephony and television; monitoring; standard-frequency and time-signal transmissions; maritime, aeronautical and land-mobile systems; and terminology.

The C.C.I.R. has been quick to recognize the importance of space communication and the possible use of satellites for linking widely separated points on the earth's surface. A new Study Group IV under Dr. Ranzi of Italy will examine this.

The amount of work done at Los Angeles is reflected in the 700 papers studied and the 200 recommendations, reports, resolutions, new study programmes and questions adopted.*

* The results of the Assembly will be published in early 1960 by the International Telecommunications Union, Geneva

Work of C.C.I.R. in Los Angeles (continued)

Advances made

Preferred characteristics were agreed for a broad series of radio systems including point-to-point, mobile and broadcasting; this will facilitate planning on an international basis, minimize interference and lead to economy in that most valuable asset the radio spectrum. Advances were made on the question of monochrome-television standards for bands IV and V; for example all the European countries said they would be prepared to accept a channel spacing of 8 Mc/s in these bands to achieve a uniform arrangement and a more efficient use of the spectrum.

The recommendations of the C.C.I.R. are not mandatory, but they are a guide to the planning, design, operation and maintenance of radio systems. In certain cases they provide the technical basis for the decisions of Administrative Radio Conferences which are binding on the countries concerned. The next Administrative Radio Conference is to be held in Geneva later this year. This C.C.I.R. meeting was therefore timely.

All the countries which took part, including the Soviet Union, worked together harmoniously and with goodwill and were able to reach a satisfactory measure of agreement on a great range of technical problems. W. J. B.

40th anniversary of SEP

SEP is the Polish Institution of Electrical Engineers. Their 40th anniversary proceedings in Warsaw in June were presided over by Prof. J. Podoski who after several years of imprisonment is Professor of Traction in the Warsaw Electrotechnical Institute. There were about a dozen foreign delegates. Mr. Davis who represented The Institution is at the National Physical Laboratory.

R. DAVIS, M.SC., MEMBER

To mark the 40th anniversary of the formation of the Polish Institution of Electrical Engineers (SEP) a congress was held in Warsaw during the week beginning the 7th June 1959. Sister organizations of other countries were invited to participate, and the invitation to our Institution was coupled with the suggestion that the delegate should read a paper at a symposium on lightning protection of structures. I accepted the invitation of the Council to represent The Institution and in that capacity was treated with great kindness and courtesy.

Prof. Jakubowski of the Polish Academy of Sciences met us on landing, saw us through entrance formalities, entertained us in his home, showed us round his department,and at considerable inconvenience to himself tried to make the visit of interest and value.

Anniversary meeting

The actual anniversary meeting was held in a lecture theatre with a seating capacity of 3000, not easily found within the Palace of Science and Culture, a skyscraping structure dominating Warsaw which was built for the Polish people by the Russians after the recent war. The anniversary meeting proper was impressive. Members and friends from all parts of Poland almost filled the theatre.

The chair was taken by Prof. J. Podoski of the Warsaw Technical University, and he was supported by ministers of state, trade union members and the foreign delegation which included a representative from Russia and most of the European countries and a delegate of the American Institute of Electrical Engineers, Polish born, who had been secretary of SEP. The chairman, whose speciality is traction, asked me to convey his greetings to our Institution with which he was closely connected during the recent war when he presided over the activities of the Polish engineers in London.

The visiting delegates were invited to address the audience in their native tongue, Prof. I. Stiekolnikow of Russia being first called on; I followed, conveyed the greetings of our Institution and suggested that both bodies had the common aim of fostering electrical science, technology and education. These speeches were translated into Polish, the subsequent proceedings being conducted in Polish with some simultaneous translation into German, English, French and Russian.

Many awards were made for services to SEP. Of three honorary memberships two were posthumous including that of Prof. Dreynowski, well known in the field of high-voltage research and in C.I.G.R.É. circles. The award winners were received with great enthusiasm by the audience and marshalled with dexterity by Secretary General Skarzyński.

The meeting ended with an address by Prof. Jakubowski on 'The role of electricity in the economic life of the country' and was followed by a choral concert and folk-dancing display by students of the Technical University.

Lightning protection of buildings

The formal ceremony had been preceded by a two-day conference on the lightning protection of buildings organized by the appropriate Polish standardizing committee. The energetic secretary of the committee, Mr. T. Gniewiewski, described the present practice in Poland. Dr. R. H. Golde of the E.R.A. gave a paper on fundamental aspects of the problem. Papers covering the characteristics of the lightning discharge, the frequency of occurrence, and the influence on the location of the discharge of geological features were presented by Prof. Stiekolnikow and Prof. M. Hillebrand the successor of Prof. Norinder at Uppsala.

The question of the effect of geological formation on stroke location aroused considerable controversy. The protagonist was Dr. Fritz of Austria who produced supporting statistical data, but the vocal majority remained unconvinced.

My contribution related to lightning-protection practice in Britain; this naturally leaned heavily on the British Standard Code of Practice for the Protection of structures against lightning for basic recommendations and for justification on the Shipley paper and associated discussion* together with experience derived from the wartime balloon barrage. The conference was conducted in German and Polish but I was permitted to speak in English, a paragraph-by-paragraph translation being provided by Engineer Radziwill, a well known name in Polish history.

* *Journal I.E.E.*, 1943, 90, Part I, p. 509

For the foreign visitors the remainder of the anniversary programme was designed to provide relaxation and entertainment. It included a banquet, receptions, and visits to the opera 'Halka' with its magnificent national dances, to the birthplace of Chopin, and round Warsaw where they are trying to rebuild and recapture some of the former character of an historic city devastated to the extent of 80–90%.

A visit to Gdansk

Prof. Szpor persuaded Dr. Golde and me that instead of visiting the Poznan fair as arranged it would be much less tiring to go to Gdansk to visit his 'ridiculous little laboratory' in the Technical University. We left Warsaw at 9 a.m. and reached our destination at midnight, the journey being punctuated by stops for lunch and for visits to a generating station protected by Spzor inductance coils and to a lightning-observation station at the top of a chemical factory.

On the Sunday morning we visited Prof. Szpor's Institute and were impressed to find that the whole of his staff were there to welcome us (a tribute to the personality of their head) and show us their work. This is largely concerned with lightning protection of transmission systems and of rural buildings, the latter being an important problem in Poland with its many wooden houses and thatched roofs, and with design problems. One gained the impression that the teaching staffs both in Warsaw and Gdansk were much occupied with design problems normally handled in the manufacturing works at home. After lunch we were taken in a fast Polish Naval craft to see the port of Gdynia.

We returned next day by train to Warsaw accompanied by one of Prof. Szpor's assistants, were escorted to the airport by our hosts and soon after had completed an assignment accepted initially with some reluctance but which left memories of interesting people and kindly hospitality.

The platform at the inauguration of the 40th anniversary congress of SEP

Left to right: R. Davis; Prof. J. Groszkowski, vice-chairman of the Polish Academy of Sciences; Prof. Podoski; Prof. S. Kuhn, vice-rector of Warsaw Polytechnic School; and Prof. I. Stiekolnikow, delegate of the U.S.S.R. Academy of Sciences

ENTRANCE FEES AND ANNUAL SUBSCRIPTIONS

As recorded on p. 414 of the July 1959 (emergency) *Journal* a Special General Meeting of Corporate members of The Institution on the 25th June 1959 confirmed a resolution of the Council effecting increases in entrance fees.

Also, as stated in the August 1959 *Journal* (p. 487) a Council resolution effecting increases in annual subscriptions was confirmed at another Special General Meeting of Corporate members of The Institution on the 18th August 1959.

The Tables below give details of the increases. The new annual subscriptions become operative on the 1st January 1960.

Entrance fees

Class of membership	Present entrance fee	Increase in entrance fee	Total new entrance fee
Members	£10 0 0	£5 0 0	£15 0 0
Associate Members	£6 0 0	£3 0 0	£9 0 0
Companions	£10 0 0	£5 0 0	£15 0 0
Associates	£6 0 0	£3 0 0	£9 0 0
Graduates	nil	nil	nil
Students	nil	nil	nil

Provided that a Graduate or Student who as such has paid not less than three consecutive annual subscriptions shall on transfer to the class of Associate Members pay an entrance fee of **£6 0s. 0d.** If he has also paid not less than three consecutive annual subscriptions as a Student over and above such three consecutive annual subscriptions as are referred to in the first sentence of this sub-clause he shall pay an entrance fee of **£3 0s. 0d.** in lieu of an entrance fee of **£6 0s. 0d.**

Annual subscriptions

Class of membership	Present annual subscription		Increase in annual subscription		Total new annual subscription	
	In Great Britain, Northern Ireland, the Isle of Man and the Channel Islands	Abroad	In Great Britain, Northern Island, the Isle of Man and the Channel Islands	Abroad	In Great Britain, Northern Ireland, the Isle of Man and the Channel Islands	Abroad
Members	£7 0 0	£6 0 0	£2 0 0	£2 0 0	£9 0 0	£8 0 0
Associate Members	£5 5 0	£4 10 0	£1 1 0	£0 15 0	£6 6 0	£5 5 0
Companions	£7 0 0	£6 0 0	£2 0 0	£2 0 0	£9 0 0	£8 0 0
Associates	£5 5 0	£4 10 0	£1 1 0	£0 15 0	£6 6 0	£5 5 0
Graduates 35 and above	£4 15 0	£3 15 0	£1 0 0	£1 0 0	£5 15 0	£4 15 0
Graduates over 28 and under 35	£4 5 0	£3 10 0	£0 12 6	£0 10 0	£4 17 6	£4 0 0
Graduates 26–28	£3 5 0	£3 0 0	£0 10 0	£0 7 6	£3 15 0	£3 7 6
Graduates under 26	£2 7 6	£2 5 0	£0 7 6	£0 5 0	£2 15 0	£2 10 0
Students over 26	£3 5 0	£3 0 0	£0 7 6	£0 7 6	£3 12 6	£3 7 6
Students 23–26	£2 7 6	£2 5 0	£0 5 0	£0 5 0	£2 12 6	£2 10 0
Students under 23	£1 12 6	£1 10 0	£0 2 6	£0 2 6	£1 15 0	£1 12 6

INTERNATIONAL COMMISSION ON ILLUMINATION

THE 14th session of the Commission Internationale de l'Éclairage was held from the 15th to 24th June 1959. The meetings took place in the Palais des Congrès, a building erected last year in the reconstruction of the centre of Brussels.

The number of delegates, 550, was somewhat greater than at the previous (Zürich) session in 1955. Twenty-six nations were represented, and the British delegation, some 80 strong, was one of the largest. For the second time in the history of the C.I.E. the President was from this country and a member of The Institution, Dr. J. W. T. Walsh, O.B.E. As at Zürich, simultaneous translation into the three official languages of the Commission (English, French and German) greatly facilitated the proceedings.

Procedure

This session was the first since the reorganization of the technical work of the C.I.E. in 1955. At that time it was decided to set up 'working committees' in which a limited number of 'experts' were given the task of studying a clearly defined problem or group of problems within a specific area of illuminating engineering. For example one such committee was set up for street lighting, another for colorimetry and so on.

When a committee arrives at a stage in its work where it seems appropriate to publish a report, usually with recommendations, it is submitted to all constituent national committees and, if approved, is published as an official C.I.E. report. Two have so far appeared, one an international lighting vocabulary and the other on the colours of signal lights.

At Brussels each of the 16 working committees (now renamed 'committees of experts') presented a brief account of their work during the intersessional period. There were also 13 reports, prepared by various national committees, on lighting subjects not dealt with by committees of experts. To provide time for discussion two meetings were held simultaneously throughout the first week of the session.

On the following Monday and Tuesday there were eight meetings (again two simultaneously) for the presentation of 23 papers on lighting by individual authors. Both reports and papers had been printed and circulated to delegates well in advance of the session, so that they could be presented quite briefly, allowing adequate time for discussion.

Lingua franca

In addition to the technical meetings a number of visits to factories making lamps or lighting equipment were arranged, while on one evening delegates interested in street lighting inspected a pair of full-scale experimental installations which had been erected on two neighbouring highways near Brussels.

As at all such international gatherings, the informal discussions between individuals or small groups of delegates were found to be a most valuable part of the proceedings. Language barriers seemed to be overcome to a large extent. It was noticeable that English was by far the most prevalent, both in the printed papers and during the discussions.

Clearly in almost every country where English is not normally used it has become the second language and the language of international communication, at any rate for technical purposes. The Soviet Union is, however, a notable exception, and it was difficult for the Russian delegates, even with the aid of their interpreter who spoke French, to take as full a share as could have been wished in the technical discussions, both at the meetings and informally.

Officers of the C.I.E. and heads of national delegations photographed from the steps of the Palais des Congrès, Brussels 1959

Social sidelights

The social side of the programme was a full one. There was an official reception at the Hôtel de Ville on the first evening and on the Tuesday a 'Concert aux chandelles' with the musicians dressed in 18th-century costume and an enactment of the story associated with Haydn's 'Farewell' symphony. The official banquet was held on the Thursday evening. On the Friday a gala ballet performance was given at the Théâtre Royal de la Monnaie exclusively reserved for the delegates and their ladies.

On the Sunday a whole-day excursion started with a journey by coach from Ostend to Knokke where an excellent lunch was provided. Then came a visit to the wonderfully picturesque town of Bruges with its medieval buildings and old-world atmosphere and, as a climax, an evening at Wieze and a never-to-be-forgotten 'Breughelian supper' (whether after the painter or his birthplace was not clear).

Vienna session

At the final plenary meeting it was decided that the next session in 1963 should be held in Vienna. The new President is Mr. Ivar Folcker of Sweden, a lighting engineer who has taken an active part in the work of the Commission over a long period, especially in 1951 when a session was held in Stockholm. (In the photograph Mr. Folcker is 12th from the left and in front.) The reports and papers, together with an account of the discussions, will be published later by the Central Bureau of the C.I.E., 57 rue Cuvier, Paris 15e.

Electrical materials for aircraft power equipment

A brief review of a Utilization Section paper (2912) entitled 'Electrical materials and components for aircraft power equipment operating at high temperatures' by D. B. McKenzie, B.Sc., Member. The paper is published in the August 1959 Proceedings, Part A. The author is at the Royal Aircraft Establishment, Farnborough.

With the introduction of faster aircraft, equipment within them will encounter higher ambient temperatures; and the electrical components can be divided into two broad classes, those that can be cooled artificially and those that must rely on natural cooling.

The first class includes a few components such as generators or similar bulky items that can be cooled individually by passing air or liquid coolant through them, and others such as capacitors, rectifiers, switchgear, relays and transformers that can be cooled as a group. The second class includes cables and their terminations, plugs and sockets and terminal blocks.

Because so few components can be cooled individually and it is impracticable to concentrate all electrical components into a few areas or compartments that can be cooled and because cooling requirements must be kept to a minimum, as much equipment as possible should be capable of operating at the ambient temperature within the aircraft.

Present electrical accessories in general will function in an ambient temperature of 70°C and may have hot-spot temperatures up to 130°C. Further development of these accessories for use without cooling in an ambient temperature of 150°C is possible, although there are isolated items such as selenium and copper-oxide rectifiers which cannot operate above 100°C. The development of equipment to work in an ambient temperature of 200°C however, with hot-spot temperatures between 250° and 300°C, is further away, as no known organic materials will withstand these temperatures for a long time. Inorganic substances can be used where suitable, but they are heavier.

Insulating materials

Insulating materials fall into two broad classes—rigid and flexible. For continuous use at or above 300°C the rigid types are all inorganic, e.g. ceramics, glasses and mica. At present the only flexible material to withstand this temperature is a new elastomer known as Viton A, a copolymer of perfluoropropylene and vinylidene fluoride; but its electrical properties are rather poor and resemble those of polychloroprene.

In the group of flexible insulating materials the silicone rubbers are extensively used up to 200°C but are liable to swell in contact with aircraft fuels. Fluorosilicones are now available which resist these fuels. Polytetrafluoroethylene (p.t.f.e.) is less flexible and resilient than silicone rubber although it may be used at slightly higher temperatures, up to about 250°C. Above this, toxic gases may be liberated.

Conducting materials

The most commonly used conducting material is copper, but it requires protection from oxidation at high temperatures. For use below 150°C tin or cadmium plating is satisfactory, but between 150° and 400°C a heavy coating of nickel is necessary. Silver-plating can be used up to 200°C, but above this the silver itself oxidizes and in turn must be protected. Gold has many advantages for this purpose, and where the conductors are small solid gold may even be economic.

Winding wires

Winding wires for aircraft electrical equipment operate at temperatures considerably higher than those laid down in B.S. 2757 owing to the relatively shorter life of aircraft equipment compared with that of a commercial machine. Silicone-enamelled wires can be used in windings at 200°C, but owing to their rather poor abrasion resistance and tendency for the enamel to flow modified silicone enamels or polyester enamels are preferred despite the lower working temperature of 180°C.

P.T.F.E. alone is an unsuitable insulation for a winding wire because of its tendency to flow, but with a glass-fibre roving a good insulation can be made although it has a poor space factor. A ceramic-loaded p.t.f.e.-covered wire has been used to a limited extent, but the insulation may flake off during the winding operation. Anodized-aluminium winding wire has been used, but the thin anodic film is porous. It can be improved by impregnating with p.t.f.e. which in turn limits the working temperature of the wire.

Magnetic materials and springs

For magnetic circuits, soft iron, silicon–iron and cobalt–iron are all practicable above 250°C, but the properties of high-permeability nickel–irons which have low Curie points may be affected above 300°C. Inorganic coatings are necessary for the laminations.

For springs operating at up to 250°C a high-chromium-content ferrous alloy may be used, but where the temperature does not exceed 150°C beryllium–copper springs may be suitable except where very heavily stressed. Nickel–chromium springs of Inconel or Nimonic can be used above 250°C.

Slot and conductor insulation

For conventional machines slot insulation is generally glass fibre or mica treated with polyester or silicone varnishes.

These varnishes can also be used for impregnating the rotating parts of the complete machine, but where good bond strength is required modified phenolic varnishes still appear to be the best. Fused silica or alumina, aluminium cements or alumina flame-sprayed onto the conductors or slots are all possible future insulations. Their use would entail considerable changes in the design of machines.

The development of basic materials for electrical equipment for high-temperature use is being actively pursued by many investigators, but the development of the equipment itself for ambient temperatures of 200°C and higher is progressing slowly. Unquestionably, isolated items will be required, but the need for a complete electrical power system to operate at an ambient temperature of 200°C is not yet established. There is little doubt however that a need will exist for a complete system for use at 150°C. 621.389:629.135

Induction-motor development

A short account of a Graduate and Student Section paper entitled 'Some aspects of induction-motor development' by H. Myers, B.Eng., Graduate. The paper is the Chairman's Address to the North Midland Graduate and Student Section delivered at Leeds on the 24th September 1957, and it was awarded a Premium by the Council. The author is with the English Electric Co. Ltd.

In 1954 a new specification (B.S. 2083) established standard ratings and fixed dimensions for totally enclosed fan-cooled squirrel-cage motors ranging from ½h.p. 8-pole to 25h.p. 2-pole. The dimensions specified were similar to those of the American Nema Standard MG1: 1949; but for a given frame size the horse-power outputs were increased to conform to the generally accepted practice in this country, and shaft dimensions were adjusted accordingly. Sufficient flexibility was allowed to enable manufacturers to include their own individual features. Fig. 1 shows the dimensions which are treated as fixed.

The extension of standardization was continued by introducing a further specification, B.S. 2960, for ventilated machines. This applies to 3-phase 50c/s squirrel-cage induction motors with ventilated enclosures of the protected, screen-protected or drip-proof types, continuously rated and with class E insulation. It covers foot, flange, horizontal and vertical skirt mounting. The shaft dimensions are increased to accord with the increased horse-power. The output range is from ½h.p. 6-pole to 50h.p. 2-pole.

The same frame nomenclature is used for both specifications, with the prefix 'B' for totally enclosed motors and 'C' for ventilated enclosures. Flange mounting is denoted by a 'D' after the frame number as shown in Fig. 2.

Maximum continuous rating

From 1936 to 1955, B.S. 168 covered the electrical performance of industrial generators and motors and specified ratings on the basis of a continuous load plus overload (c.r.p.o.). B.S. 2613: 1957 specifies the ratings in terms of maximum continuous load (m.c.r.) and adjusts the temperature increases accordingly; it also introduced new classes of insulation based on the better materials now available.

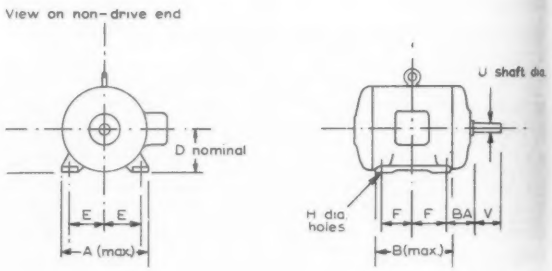
Maximum continuous ratings are thought to be more easily matched to actual loading conditions in industry, and this specification now unifies the entire electrical performance of all generators and motors of outputs equal to or greater than 1h.p., 0·75kW or kVA per 1000r.p.m. for normal industrial use.

Classes of insulation

The permissible temperature rises for a.c. windings below 1000 volts are as follows:

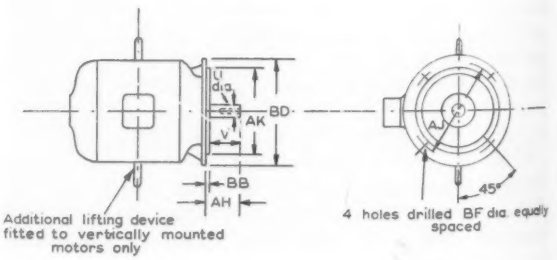
	Class of insulation				
	A	E	B	F	H
	°C	°C	°C	°C	°C
B.S. 2613	55	65	75	95	115
B.S. 168—					
Machines other than totally enclosed	40	—	50	—	—
Totally enclosed machines ..	50	—	65	—	—

in an ambient of 40°C



1 (above) *Standardized dimensions for foot-mounted motors*

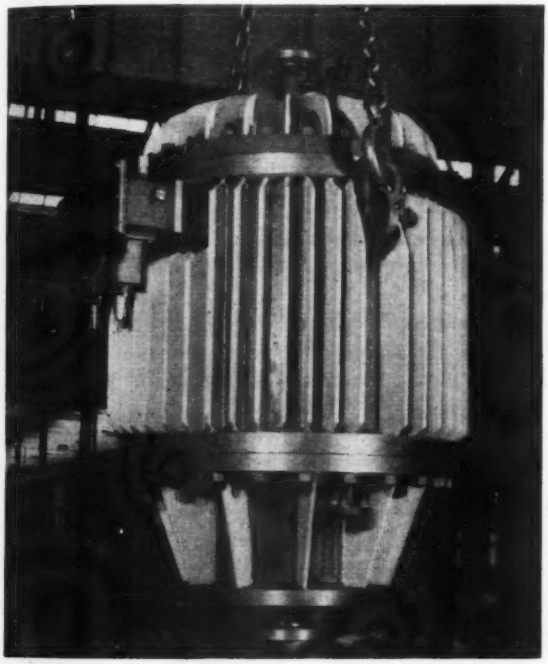
2 (below) *Standardized dimensions for flange-mounted motors*



These higher temperatures have enabled a greater output to be obtained from the same frame—or a reduction in active material for a given output; yet modern insulation permits a winding life expectation of 20 years.

Classes A and B have long been recognized, but classes E, F and H are more recent developments which are due to a better knowledge of the properties of insulating materials.

The basis of class A materials is cotton, silk and paper when suitably impregnated. Class E is more loosely defined as those materials or combinations of materials which experience shows will withstand the higher temperatures specified, and Terylene has been used instead of cotton. Both classes, however, permit the use of polyvinylformal-covered wire.



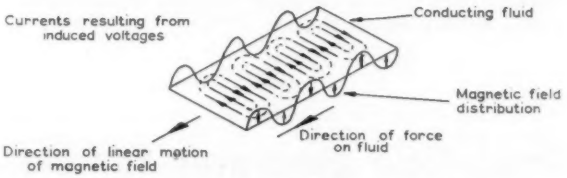
3 *25h.p. 75r.p.m. stainless-steel purged motor for operation at 350 volts 3-phase 10c/s*

Glass, mica and asbestos are the basic materials of class B insulation. Class H specifies the same but includes silicone elastomer with silicone resins as the bonding, coating and impregnating materials. Class F is a compromise between classes B and H, allowing class B materials to be used with impregnation in an alkyd resin instead of the more costly silicone varnish.

Purged motors

A development which may result in a Group IV flame-proof certificate is the purging of an induction motor with air or an inert gas.

A totally enclosed motor is fed with air at a pressure greater than that of its surroundings. This prevents the risk of an explosion occurring inside the machine, since the explosive gases cannot enter against the excess internal pressure. A pressure switch is incorporated so that, should the pressure within the motor fall below that of its surrounding atmosphere, the supply is automatically tripped.


Currents resulting from induced voltages
Conducting fluid
Magnetic field distribution
Direction of force on fluid
Direction of linear motion of magnetic field

4 *Operation of a linear-induction electromagnetic pump*

Canned motors

Fresh interest in canned motors is largely the outcome of the utilization of nuclear energy, though they had previously been used in a very much simpler form for submersible pumps. In nuclear power plants the heat generated by atomic fission is transferred to a pumped fluid in a hermetically sealed system. This fluid is at a high temperature and pressure, and because of its radioactivity the most minute leakage cannot be permitted.

The normal shaft seal between motor and pump had therefore to be eliminated by placing both in a single pressure-tight housing made in two parts, then bolted and seal-welded in position. The pumped fluid is used as the lubricant. The bearing materials must therefore be extremely good, corrosion-resistant and compatible with the pumped fluid. Carbon bearings with the bearing surface of the shaft hardened have been used.

The stator windings are protected from attack by lining the stator bore with a thin hollow cylinder of a non-magnetic corrosion-resisting material. The squirrel-cage rotor is protected in a like manner, and these 'cans' are welded leak-tight in position. A centrifugal pump is overhung on the motor shaft, and the complete unit is hermetically sealed into the pipework.

Electromagnetic pumps

The electromagnetic pump has a flat stator containing a polyphase distributed winding in slots in a laminated core. The currents in this winding produce a linear travelling magnetic field. A column of the conducting liquid lies in a duct across the face of the core, and the voltages induced in the fluid result in a force along the duct. The integrated effect of this force is the pressure of the pump (see Fig. 4).

Two flat stators are placed on opposite sides of a layer of conducting fluid (usually sodium) and connected so as to

produce additive magnetic fields. The pump duct forms the fluid enclosure and contains no working parts and no seals. The external structure consists of the magnetic circuit and electrical windings and is filled with an inert gas during operation. This prevents the sodium reaching the outside air in the event of a leak in the duct.

In order to remove heat from the stator, cooling water is circulated through the assembly, and copper laminations are inserted at intervals in the electrical steel to increase thermal conductivity. Owing mainly to the high slip and large air-gap (duct wall), efficiency and power factor are of the order of 45% and 0·4 respectively. 621.313.33

Cross-field generator for closed-loop systems

A short review of a Graduate and Student Section paper entitled 'The cross-field generator and its application to closed-loop control systems' by A. R. Daniels, M.Sc., Student. The paper was read before the Graduate and Student Section of the Western Centre at Bristol on the 30th October 1957 and was awarded a Premium by the Council. The author is at the College of Technology, Bristol.

An essential feature of any control system is the use of an amplifier to provide large compensating powers. While there are many kinds of amplifier available for use by the engineer the cross-field generator which is in effect a two-stage rotating amplifier is of particular importance for the precise and smooth control of quantities such as the output of a generator, the speed or torque of a motor, or the position control of a remote piece of apparatus.

The cross-field generator

The connections of the metadyne generator are shown in Fig. 1. If the control field voltage V_f is maintained constant the control field flux Φ_f is also constant. Rotation of the armature in this constant flux produces a constant e.m.f. V_q on the short-circuited quadrature axis. A current I_q flows and a flux Φ_q is set up. Rotation of the armature in the flux Φ_q produces an e.m.f. V_d on the direct axis, and when a load current I_d flows an armature reaction flux Φ_d is set up. Rotation of the armature in this flux induces an e.m.f. V_q' on the quadrature axis.

The metadyne generator is a constant-current device, and this can be seen if Kirchhoff's laws are applied to the quadrature axis. When the small voltage drop on the quadrature axis is neglected $V_q' = V_q$. Thus the output current I_d which is proportional to V_q' is constant.

In the amplidyne generator the m.m.f. due to the output current is compensated for by the introduction of a winding connected in series-opposition with the direct-axis brushes. The term 'amplidyne generator' is usually reserved for machines with 100% compensation, and in this case V_q' is opposed by an equal e.m.f. V_c. The constant e.m.f. V_q produces a constant current I_q and a constant flux Φ_q on the quadrature axis. Rotation of the armature in this constant flux produces a constant e.m.f. on the direct axis. The amplidyne generator is therefore a constant-voltage machine and can be represented by two d.c. generators with separate excitation operating in cascade.

A more general analysis of the steady-state operation of the amplidyne generator results in the expression:

$$V_d = K_A V_f - I_d R_d \qquad \ldots\ldots (1)$$

for the output voltage V_d where K_A is the voltage-amplification factor and R_d the resistance between the direct-axis brushes.

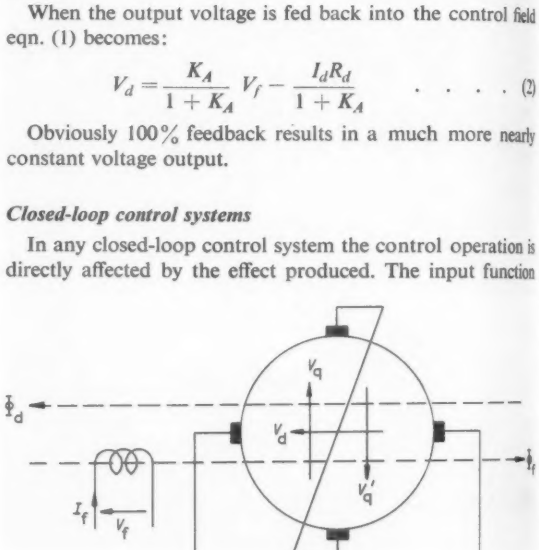
When the output voltage is fed back into the control field eqn. (1) becomes:

$$V_d = \frac{K_A}{1 + K_A} V_f - \frac{I_d R_d}{1 + K_A} \qquad \ldots\ldots (2)$$

Obviously 100% feedback results in a much more nearly constant voltage output.

Closed-loop control systems

In any closed-loop control system the control operation is directly affected by the effect produced. The input function



1 *Connections of the metadyne*

$\theta_i(t)$ and the output function $\theta_o(t)$ are known quantities, and the unknown error function $\epsilon(t) = \theta_i(t) - \theta_o(t)$ must be found and chosen so that the system is stable. A general treatment of stability is beyond the scope of this paper, and particular forms of stabilizing feedback are used where necessary.

Closed-loop control systems can be generally defined as either regulating systems or servomechanisms. Three applications of the cross-field generator to closed-loop control systems are considered below of which two are regulating systems and the third is a servomechanism.

Control of d.c. generator output

The output of the amplidyne is fed into the separately excited field of the d.c. generator under control, and the full output of the d.c. generator is fed back into the control field of the amplidyne. The over-all stability of the system must be considered, and the transient analysis results in the equation:

$$V_f\left[1 + \frac{K}{(1 + \mathrm{D}T_1)(1 + \mathrm{D}T_2)}\right] = V_1 \quad . \quad . \quad . \quad (3)$$

where V_f is the error voltage, V_1 is the constant reference voltage, K is a constant, T_1 and T_2 are time-constants of the system, and $\mathrm{D} = d/dt$.

The actual system tested was found to be stable in all operating conditions.

In steady-state conditions V_f increases or decreases with increase or decrease in the output voltage and is the type of error required for this application.

Control of d.c. motor speed

The output from the amplidyne is used to supply the field of a separately excited generator. The armature output of the d.c. generator feeds the motor under control. (Alternatively the output of a metadyne can be used to supply the motor armature directly). Voltage feedback into the control winding is taken from a small tachogenerator coupled to the motor under control.

The general analysis results in the expression:

$$V_f\left[1 + \frac{K}{\mathrm{D}(1 + \mathrm{D}T_1)(1 + \mathrm{D}T_2)(1 + \mathrm{D}T_3)(1 + \mathrm{D}T_4)}\right] = V_1 \quad (4)$$

A system of this type involving several time-constants is generally unstable. In this particular case stabilizing feedback was applied to a second control-field winding from the armature input of the motor through an *RC* differentiating circuit.

In steady-state conditions V_f changes with change in speed of the motor under control.

Position control of remote apparatus

A simple servomechanism for an application such as the remote control of the heavy armament of a warship consists of two magslips used in conjunction with a cross-field generator. The magslips are connected so that the error ϵ is proportional to the misalignment between the input and output shafts. The error is amplified and applied to the control field of the amplidyne which supplies the armature of the main driving motor.

The output magslip is connected to the main motor through suitable gearing. While there is a misalignment between the input and output shafts the main motor will be supplied from the amplidyne and will rotate. Since the main motor is coupled to the output magslip this rotation will continue until there is no misalignment between the input and output shafts. The system involved several time-constants and was found to be unstable. Stabilizing feedback was applied to the electronic amplifier used to amplify the error function.

A steady velocity of the input shaft gives the same output velocity, but the output lags behind the input by an angle proportional to the velocity.

It is an important feature of a servomechanism of this type that it is not necessary to refer continually to zero as a datum level. 621.313.236.2

Ferrite boundary-value problem in a rectangular waveguide

A synopsis of an Electronics and Communications Section paper (3056) with the above title by L. Lewin, Associate Member. The paper will be published in Part B of the Proceedings. The author is with Standard Telecommunication Laboratories Ltd.

USING a published formulation of the equations for reflection of an electromagnetic wave from a transversely magnetized ferrite block in a rectangular waveguide, the author gives a solution in closed form for the integral equation involved.

He discusses in detail this solution in a certain range of the gyromagnetic parameter and shows that outside this range the published solutions are faulty and the present solution is also unusable, for unknown reasons. A second-order solution is given, and reasons are advanced for believing that quasi-static approximations are not the cause of the difficulties encountered. 621.372.822

Synopses of papers

THE following are synopses of papers published in the *Proceedings* which have not been read at Institution meetings and which have not been reviewed in the *Journal*. They are included here primarily for reference. The papers have not been published individually, as have those for reading at meetings, but reprints will be available in due course

Location of dry joints in telecommunication cables

A synopsis of an Electronics and Communication Section paper (3025) entitled 'A method of locating dry joints in telecommunication cables' by J. Rhodes, M.B.E., B.Sc.(Eng.), Associate Member. The paper will be published in Part B of the Proceedings. The author is in the Post Office Engineering Department.

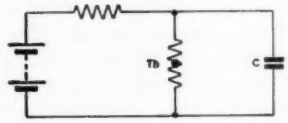
THE author describes a method of locating dry joints in telecommunication cables. This is based on the non-linear properties of dry connections and has been used successfully on land and submarine cables. 621.317.34:621.315.2

CORRESPONDENCE

THERMAL ELECTRIC OSCILLATORS

IT has been known for some time that a biased thermistor will behave in the same manner as a large inductor (in its phase-shifting properties) towards small-amplitude very-low-frequency alternating currents. This incremental property arises from its negative temperature coefficient of resistance and the effect of thermal inertia. A thermistor biased beyond its turnover current will behave as a perfect inductor at a certain critical frequency dependent on the thermal time-constant. At lower frequencies the equivalent impedance contains, in addition to a reactance, a negative resistance component.

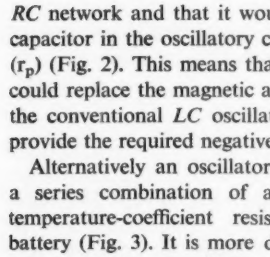
J. E. Stone* showed that it was possible to produce self-maintained oscillations in a circuit (Fig. 1) consisting solely of a biased thermistor (Th) and a large capacitor (C).



1

It was later pointed out by F. J. Hyde† that a resistor with a positive temperature coefficient of resistance would, for a range of very low frequencies, show the phase-shifting properties of an *RC* network and that it would seem possible to replace the capacitor in the oscillatory circuit (Fig. 1) by such a resistor (r_p) (Fig. 2). This means that the two thermal energy stores could replace the magnetic and electrostatic energy stores of the conventional *LC* oscillator. The thermistor would also provide the required negative resistance.

Alternatively an oscillatory circuit could be formed with a series combination of a thermistor (Th), a positive-temperature-coefficient resistor (r_p), and a low-voltage battery (Fig. 3). It is more difficult however to achieve the necessary bias conditions for these two simple circuits (Figs. 2 and 3) than in the circuit to be described.



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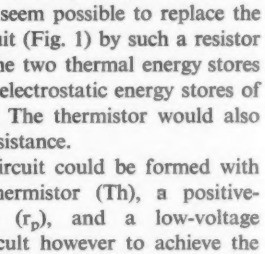
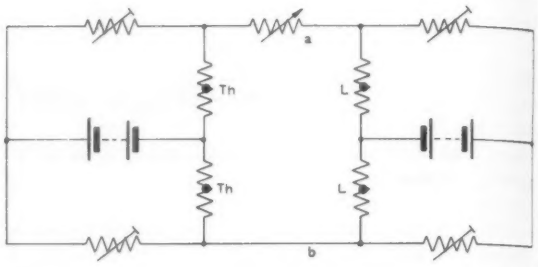


3

The writer has recently developed a circuit containing only thermistors (Th) and tungsten-filament lamps (L), together with two batteries and resistance boxes, which will oscillate continuously at a frequency of 0·03c/s. To allow the independent adjustment of the biasing currents (essential with the elements available) it was necessary to use two similar lamps and two similar thermistors in a 'back-to-back' circuit (Fig. 4). There was found to be no obvious distortion of the voltage waveform between and with an amplitude of 1 volt, but the amplitude stability remains to be improved.



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Replacement of the lamps by small positive-temperature-coefficient resistors designed to allow easy biasing would make a simple, extremely compact v.l.f. oscillator.

We are co-operating with Dr. R. W. A. Scarr and his colleagues of Standard Telephones and Cables Ltd., Footscray, Kent, in the design of an oscillator using positive-coefficient silicon resistors.

The writer wishes to acknowledge his indebtedness to Dr. H. House and other members of the Electrical Engineering Department of Northampton College.

J. D. BROWNLIE, B.SC.(ENG.), GRADUATE
Department of Electrical Engineering
Northampton College of Advanced Technology
St. John Street
London E.C.1

19th June 1959

WHAT IS NEGATIVE IMPEDANCE?

PROF. Myers's appraisal (August 1959 *Journal*, p. 471) of my observations (March 1959 *Journal*, p. 169) is perplexing unless it is to cover his annoyance with the American reference. An interpretation has been put on the statements which was certainly not intended by me, and I respectfully submit that the Professor has missed the point by a long chalk.

In quoting the officially backed definition of impedance, incomplete though it may be as the Professor points out, I thought that even the high-school boy would know it was the opposition of the circuit to alternating current that was being discussed and not the impedance operator obviously.

But I shall not bore readers of the *Journal* by answering Prof. Myers's gibes which I do not think are worthy of even an assistant professor. I shall merely state that I am wholeheartedly in agreement with him that the impedance operator, which I assume he means by 'the definition', is mathematical: that I would not dream of giving it another interpretation than a means to an end: and that I was interested in impedance not in its symbolic representation.

* STONE, J. E., *Electronics*, 1950, 23, p. 94
† HYDE, F. J., *British Communications and Electronics*, 1957, 4, p. 16

I am however not intrigued that Prof. Myers cares to identify the negative title with say $\angle Z\ 240°$ but not equally with say $\angle Z\ 120°$.

He would be on more solid ground if he dropped the title altogether. It is incredible that anybody would assume these to be one and the same statement.

There should be a collective awareness in the academic profession of the urgent need for a sound and consistent terminology in a.c. circuit theory. It is abundantly clear from contemporary books and the various papers on the subject that they and the appropriate committees of the various professional institutions should meet to establish a universal language of discussion and to find an explanation of impedance which may be dignified by the name definition, as the present definitions seem to have no official backing and some have only a limited degree of common usage.

M. O. WILLIAMS, B.SC., MEMBER
77A Court Hey Avenue
Liverpool 14

27th June 1959

SYMBOLS FOR SPACE CO-ORDINATES

FOR those who have the responsibility of teaching electrical engineering one of the most important tasks, growing in urgency with the complexity of the work, is the achievement of greater unification in the presentation of its various aspects. Only by success in this will teachers be able to deal adequately in the time that can be allotted to academic studies with the essential principles so vital to a proper understanding of engineering science.

One of the ways in which that aim can be furthered is by the general acceptance of an agreed system of symbols for the space co-ordinates applied to the analysis of all electromagnetic-wave problems whether the discussion be in terms of the electric and magnetic fields appropriate to high frequencies or of the circuit parameters more particularly associated with line transmission at low frequencies.

Some of the relevant requirements are interpreted universally in the same way, and the conventions have become well established. All electrical engineers and physicists use the right-hand screw rule, applying it to determine, from the direction of traverse when turning by the shortest route from the transverse components of electric field E to magnetic field H, the corresponding direction of power P or positive wave impedance, linking up this conception with the x, y, z sequence of a Cartesian co-ordinate system (Fig. 1a).

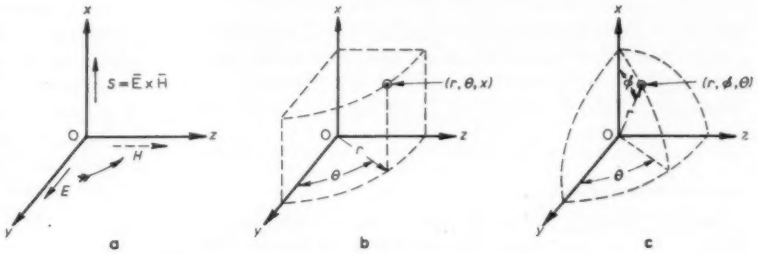
Moreover it has become the accepted practice in transmission-line calculations based on distributed circuit parameters at power frequencies upwards to take the co-ordinate x as the direction of propagation, and this inescapably implies associated electric and magnetic field components in the y and z directions respectively.

Unfortunately an anomaly is frequently introduced when translating from line theory to field theory because in the latter case so many authors use z for the principal direction of propagation, thereby requiring a re-orientation of the Cartesian co-ordinate system applicable to that kind of analysis. The unification so desirable in the presentation of circuit and field theory is thereby destroyed, and an unnecessary complication arises when reconciling theoretical investigations from the two points of view.

There are many occasions when a problem can usefully be tackled by both circuit and field theory with obvious advantages in maintaining the same reference system throughout the argument. The derivation of the so-called line equations from Maxwell's equations is always an illuminating experience for students, and to do justice to the exercise it is clearly important to avoid the confusion which would arise from a rotation of the co-ordinates as the discussion progresses from field to circuit theory.

In the literature of mathematical physics z is now almost invariably used as the principal direction of propagation, and to attempt to change that would no doubt be difficult. But in electrical engineering and particularly in the *Proceedings* of The Institution we surely ought to set a consistent pattern of symbols on a rational basis. To avoid confusion with the symbol for current we chose some years ago to break away from the language of mathematical physics and to use j instead of i for $\sqrt{-1}$.

There can be no doubt about the advantages that have accrued from that step, and in dealing with the present problem of co-ordinates it is suggested that when employing the Cartesian system x should always be used as the principal direction of propagation. The cylindrical and spherical co-ordinate systems can then be conveniently related to the Cartesian one as shown in Fig. 1b and c. Bearing in mind the shortage of available symbols the use of r for radius is recommended in both cylindrical and spherical co-ordinates.



1 *Preferred symbols for co-ordinate systems*

a Cartesian (rectangular) co-ordinates
b Cylindrical co-ordinates (θ is preferable to ϕ which is generally used for time phase angle)
c Spherical co-ordinates (r and θ as in cylindrical co-ordinates)

If agreement between electrical engineers can be reached now on the choice of such a rational system of symbols for the space co-ordinates much time and trouble can be saved in the future.

Prof. H. E. M. BARLOW, PH.D., B.SC.(ENG.), MEMBER
University College London

8th July 1959

Correspondence (continued)

ELECTRIC CONTROL OF STAGE AND TELEVISION LIGHTING

I FREQUENTLY heard on a recent extensive tour of the United States that Britain provides the ideas and America develops them. Radar and television are of course quoted as examples. Is this because we are reluctant to accept new ideas, and turn them down far too readily?

When Mr. F. P. Bentham read his paper on the 12th December 1957 I mentioned that the large variety of changes in lighting 'suggests the possibility of a punched card recording the preset combination'. In his reply Mr. Bentham said '. . . completely automatic operation has no place' (*Proceedings I.E.E.*, Paper No. 2424 U, April 1958 (**105 A**, pp. 139, 140).

In the American *Business Week*, 23rd May 1959, p. 117, there is an article entitled 'Show goes on—by punch card—Automatic system handles lights for entire production with up to 150 changes'. The name of the company developing the system and photographs are shown.

P. E. M. SHARP, B.SC.(ENG.), ASSOCIATE MEMBER
46 Hyde Vale
11th July 1959 London S.E.10

I.E.C. MEETINGS IN MADRID

AT the meetings of the International Electrotechnical Commission held from the 29th June to 10th July 1959 in Madrid 23 countries were represented and of the 640 delegates 83 were from the United Kingdom.

The Council, meeting under the chairmanship of Dr. I. Herlitz of Sweden, President of the I.E.C., approved an application for membership from the Pakistan Standards Institution and agreed that subscriptions from the I.E.C. national committees in each member country should be raised by a third.

The Committee of Action decided that a new technical committee should be set up to deal with cables, wires and waveguides for telecommunication and electronic equipment. They also agreed to call a round-table conference of interested international organizations to consider electro-heating, in particular the field to be covered by the I.E.C. and the best way of starting work.

Sign of reactive power

Thirty technical committees and subcommittees met in Madrid. At the meeting of the committee on electric and magnetic magnitudes and units it was announced that the proposal regarding the sign of reactive power had now been approved and the following I.E.C. recommendation would be issued:

'The positive sign shall be given to the reactive power absorbed by an inductor. The use of the adjectives "inductive" and "capacitive" is not necessary in connection with the term "reactive power".'

A table of conversion factors for passage from C.G.S. systems to the M.K.S. system of units, forming part of the I.E.C. recommendation on rationalization of the electromagnetic field equations, is being circulated for comment to the national committees. The proposal that the name Giorgi should be given to the M.K.S. system is being sent round for final approval.

The committee on switchgear and control gear approved for six-month circulation documents on asymmetrical breaking capacity of circuit-breakers, testing of circuit-breakers with respect to the switching of overhead lines on no load, and low-voltage distribution switchgear.

Ratings of semiconductor devices

The committee on electronic tubes and valves have approved for circulation a number of proposals including those concerning measurement of hum and hiss and of direct inter-electrode capacitance, a system of numbering electrodes, and the essential ratings and characteristics of semiconductor devices.

At the first meeting of the new technical committee on electric fans domestic table and ceiling types were discussed. Certain national committees promised to make tests in accordance with the proposals of the Indian secretariat (based largely on B.S. 380 and B.S. 367) so that minimum performance values can be considered at the next meeting when ventilating fans will also be dealt with.

Another new technical committee, on electrical equipment of machine tools, met for the first time and decided to draw up I.E.C. recommendations in two parts, one dealing with general-purpose machines as defined by I.S.O. in its test code on this subject and the other covering special machines.

MONOGRAPHS
published individually this month

Microwave tubes—An introductory review with bibliography *Monograph* 343E A. F. HARVEY, D.PHIL., B.SC.(ENG.)

DR. HARVEY reviews the various types of electron vacuum tube used for amplification and generation at microwave frequencies. Emphasis is placed on principles of operation and on tubes recently developed to give high power output, oscillations at the highest frequencies and low noise factors. The treatment is restricted to conventional tubes in which the output energy is derived from the d.c. input. The subject is interpreted in terms of published work, the text being closely associated with a bibliography up to May 1958.

After a general introduction the first part discusses grid-controlled tubes. It is then shown how the interaction of space-charge waves with resonant cavities and slow-wave circuits results in the various forms of drift-space and growing-wave tubes. The second part deals with crossed-field interaction in planar and circular geometry and includes an examination of the magnetron. An account is given of novel methods of generation of submillimetre waves, and the usual sources of electrons are described. The third part analyses noise phenomena in oscillators and amplifiers.

OBITUARY

COMFORT AVERY ADAMS

Prof. Comfort Avery Adams who was born at Cleveland, Ohio, on the 1st November 1868 died in Philadelphia on the 21st February 1958. He was educated at Cleveland Central High School and at the Case School of Applied Science. In 1890 he was awarded the B.S. degree in mechanical engineering, there being no course in electrical engineering at Case at that time. In 1905 he was awarded the electrical engineering degree by Case and in 1925 the doctorate of engineering.

After graduating in 1890 he joined the Brush Electric Co., Cleveland. In 1891 he was appointed instructor in electrical engineering at Harvard University where he became successively assistant professor and professor, becoming in 1936 James Lawrence and Gordon McKay professor of electrical engineering, emeritus. From 1914 to 1917 he was a professor of electrical engineering at the Massachusetts Institute of Technology when engineering at Harvard merged with that at the Institute. In 1919–1920 he was dean of the school of engineering at Harvard University.

In 1905 he presented before the American Institute of Electrical Engineers a general paper 'Study of the design of induction motors with special reference to magnetic leakage'. This paper contained several new methods of calculation which were more precise than any that had been developed before and was considered in the art as a basic contribution which advanced materially the analysis of induction-motor design and operation. Then followed many other notable contributions to the design and performance of electrical machinery and apparatus.

As chairman of the American Institute of Electrical Engineers' Standards Committee he instigated what is now the American Standards Association. In 1918–1919 he served as president of the American Institute of Electrical Engineers. In 1938 Lehigh University awarded him the honorary doctorate of engineering.

Although Adams retired from teaching in 1936 he continued actively in research and in consulting to industry. He did not accept full retirement until January 1956. In 1894 he married Elizabeth Challis Parsons who predeceased him. They had two sons, John and Clayton Comfort; the latter died in 1952.

He joined The Institution as a Member in 1909. A. H.

LEWIS WINTER BARNEY

Lewis Winter Barney who died on the 30th September 1958 was born on the 14th October 1885. He was educated at the Royal Belfast Academical Institution, followed by part-time study at Belfast Technical Institute and at Loughborough Technical Institute while apprenticed to Victor Coates and Co. and Brush Electrical Engineering Co. respectively.

In 1908 he joined the Scottish Central Electrical Power Co. as substation attendant and engineer-in-charge but in 1910 transferred to Willesden District Council to be appointed charge engineer.

In 1912 he decided to explore the newly opened field in oil. He became assistant electrical engineer with the Mexican Eagle Oil Co., Mexico, which was then a subsidiary of S. Pearson and Sons. On the outbreak of the 1914–18 War he returned to England to work for the parent company before he joined the Royal Flying Corps. He reached the rank of captain in the Corps and spent many months in France in a fighting squadron.

On demobilization he returned to Pearson's as electrical engineer, working on the electrical plant for contracts and purchase, and inspection and testing of electrical plant for allied companies abroad. In 1924 the company joined Dorman and Long and he was appointed chief electrical engineer, engaged in developing collieries etc. in Kent.

In 1928 he became local engineer and manager to the S.E. Kent Electric Power Co. The Company was owned by the old County of London, and in 1934 he was transferred as engineer to Richmond Electric Light and Power Co. and later to Sevenoaks Electric Co. Just prior to the Second World War he joined the Ediswan Cable Co. as an electrical engineer in the contracts department. During the war he served with the Royal Air Force and at Dunkirk managed to get his unit across France to the west coast. Later he went to Malaya but during the retreat was captured by the Japanese. He returned to the Ediswan Cable Co. after the war, but his health had been so affected during his internment that he was forced to retire.

He suffered a good deal but never complained, and was full of Irish ready wit. He is survived by his widow.

He joined The Institution as a Student in 1908 and was elected an Associate Member in 1911 and a Member in 1929.

WILLIAM BIRD

William Bird, C.B.E., J.P., who died on the 9th April 1958 was born on the 9th February 1890. He was educated at Tollington Park College and received his electrical engineering education at Finsbury Technical College.

In 1907 he joined the Gilbert Arc Lamp Co., Chingford, Essex, which he served in many capacities until his retirement in 1949. This company became in 1920 the Engineering and Lighting Equipment Co. of which Bird was co-founder and the first managing director.

He was mayor of St. Albans four times and filled many other official appointments in the city and in Hertfordshire. He is survived by his widow.

He joined The Institution as an Associate Member in 1918 and was elected a Member in 1939. He was appointed a Commander of the Order of the British Empire in 1945.

ALFRED REGINALD BLANDFORD

Alfred Reginald Blandford who died on the 11th April 1959 was born at Walsall on the 19th November 1891. He was educated at Walsall and Birmingham Technical Schools, and his early training and experience was with the Walsall Electric Co. where he became assistant manager.

He joined the Electric Construction Co., Wolverhampton, in 1916 as an assistant switchgear engineer and in 1923 transferred to the switchgear department of the English Electric Co. with whom he stayed for the remainder of his career. Within four years he became chief engineer and manager of the switchgear department and held this position for 22 years. In 1949 he was appointed chief electrical engineer of the company, relinquishing this position on attaining the age of 65 but remaining with the company in a consulting capacity until his sudden death.

He was closely associated with the introduction of arc-control devices in oil circuit-breakers and the development of the high-voltage air-blast breaker and of the medium-voltage air-break circuit-breaker—the advantages of which in power-station auxiliary gear he was quick to realize. As chief electrical engineer he was able with great advantage to the company to bring to bear his wide experience of the application and development problems of electrical equipment and during the last two years of his career devoted much of his time to passing on his knowledge to the younger generation of engineers of the company.

He represented the company on many committees including the British Standards Institution, the British Electrical and Allied Manufacturers' Association, the Electrical Research Association, the Association of Short-Circuit Testing Authorities, and the International Electrotechnical Commission. He was also the United Kingdom representative to the International Conference on Large Electric Systems (C.I.G.R.É.).

He was a keen golfer and was president of the Brocton Hall Golf Club in 1949 and 1950. He is survived by his widow and a daughter.

He joined The Institution as an Associate Member in 1941 and was elected a Member in 1943. He served on the South Midland Centre Committee from 1949 to 1955, being vice-chairman from 1952 to 1954 and chairman in 1954–55. He served on the North Staffordshire Sub-Centre Committee in 1954–55 and on the Research Committee from 1954 to 1956. His paper entitled 'Air-blast circuit-breakers' was published in the *Journal* in 1943. R. P. E. T.

CLAUDE HAMILTON BRAZEL

Lt.-Col. Claude Hamilton Brazel, C.M.G., M.C., who died on the 26th April 1959 was born at Swansea on the 12th May 1894. He was educated at Swansea Municipal Secondary School and received his engineering training conjointly at the Swansea Technical College and with the Swansea Corporation electricity department.

He was commissioned in the Royal Engineers in the 1914–18 War and served with the 38th (Welch) Division until 1919. He was awarded the Military Cross and the Croix de Guerre (Belge) and was mentioned in dispatches.

He resumed his engineering work with the English Electric Co., Stafford, and held several positions in connection with electricity supply in South Wales before being appointed in 1926 director of the electricity department of the Bahamas Government where he reorganized and extended the electricity supply system.

In 1934 he was transferred, as chief engineer and manager, to the department of electrical undertakings, Government of Ceylon, where he was engaged in bringing electricity supply to the surrounding districts and in restarting the hydroelectric work. In the recent war he formed and commanded the Ceylon Electrical and Mechanical Engineers. In 1948, owing to ill-health, he retired.

On his return to England he joined Messrs. Preece, Cardew and Rider. He reported on several oversea electricity undertakings, but his ill-health necessitated his final retirement at the end of 1953.

While in Colombo he took a great interest in the Swimming Club and was chairman for some years. He was always a very cheerful companion in spite of his physical disability. He is survived by his widow and two sons.

He joined The Institution as a Student in 1915 and was elected a Graduate in 1921, an Associate Member in 1921 and a Member in 1935. He was appointed a Companion of the Order of St. Michael and St. George in 1948. E. B. C.

JOHN SISSON ST. GEORGE COOPER

John Sisson St. George Cooper, M.A., B.SC., who was born on the 23rd April 1878 at Timaru, New Zealand, died on the 17th December 1958. He was educated at Timaru High School and at Christchurch Boys' High School, followed by a four-year course at the University of New Zealand where he obtained the degrees of B.A., M.A. and B.Sc.

On graduation he took up teaching science in secondary schools in New Zealand until 1905 when he joined the British Westinghouse Electrical and Manufacturing Co., Manchester, as engineer and designer. He spent one year in Russia during his period of service with the company.

In 1910 he became an engineer with Samuel and Co., Shanghai, being appointed chief engineer in 1912. He joined Arnhold and Co., Shanghai, as chief engineer in 1914 and was later made a director. He remained with the company for 11 years before setting up in business on his own account. In 1927 he was appointed divisional manager in Shanghai and Hong Kong to Imperial Chemical Industries (China) Ltd. He retired from the company in 1936.

He delivered the first lecture in Christchurch on 'Wireless telegraphy' and wrote several papers which were read before the Engineering Society of China.

He is survived by his widow who now lives in Sussex.

He joined The Institution as an Associate Member in 1908 and was elected a Member in 1916.

CHARLES WILSON CROSBIE

Charles Wilson Crosbie who was born on the 1st December 1883 died on the 26th February 1959. He was educated at Maini Pal, India, and then came to this country to study full-time at Nottingham University College where he gained a diploma in engineering. In 1902 he joined the British Westinghouse Co., Manchester, and remained with the company for six years before becoming chief electrical engineer to Bradbury Braby and Co., Bombay.

He returned to British Westinghouse in 1911 for a year and was then appointed deputy sales manager with Ferranti Ltd. In 1918 he joined the D.W.B. Air Ministry as civil engineer, and from 1922 to 1939 he represented companies in the foreign varnish trade in Great Britain, among them being Emil Haifely of Basle. In 1941 he joined the Brush Electrical Engineering Co. as technical representative.

The latter end of his life was attended by various difficulties which were substantially ameliorated by life at Hurst Grange where he died. He is survived by his widow.

He joined The Institution as a Member in 1942. J. F. S.

SIR JOHN CORNELIUS JOSEPH DALTON

Sir John Cornelius Joseph Dalton who died on the 14th May 1959 after a long illness was born on the 14th February 1885 and was qualified in both the legal and electrical engineering professions.

He was educated at the City of Westminster School and part-time at Regent Street Polytechnic. In 1904 he entered the Post Office telegraph department as a counter clerk and telegraphist. He served with the Royal Engineers in the 1914–18 War, reaching the rank of staff captain. On demobilization he studied law, qualifying as a barrister in 1922. After two years' practice at legal bar, mainly parliamentary bar on electricity orders and private bills, he was appointed legal adviser to the Electricity Commission. In 1927 he joined the County of London Electric Supply Co., becoming director and general manager. During the Second World War he was regional controller of fuel and power for London and S.E. England. He was knighted in 1942. In 1945 he was appointed a director of the London Power Co. but relinquished the position on the nationalization of the supply industry and joined the Cable Makers Association as its director. In this capacity he had the arduous task of presenting the association's case before the Monopolies Commission.

Sir John joined W. T. Henley's Telegraph Works Co. as chairman in succession to Sir Montague Hughman in 1953. He resigned this position in 1958 but remained on the board until his retirement in 1959. He was chairman of Southern United Telephone Cables Ltd. and a director of Henley-Simplex Africa (Pty.) Ltd. until the time of his death. In 1956 he was president of the British Electrical Power Convention at Torquay.

A keen sportsman and a great believer in physical fitness, Sir John retained an athletic physique until his final illness. In his younger days he was a talented amateur boxer, and in his later years he enjoyed a game of golf. He was also an enthusiastic swimmer and regularly used a private pool in the grounds of his Surrey home. He took an active interest in local affairs. He was chairman of the committee for the preservation of Holmwood Common, and when the common was handed over to the National Trust he remained as chairman of their committee of control up to his death.

He is survived by his widow and a married daughter by his former marriage. His only son, John Michael, was killed serving in the Parachute Regiment in 1944.

He joined The Institution as an Associate Member in 1919 and was elected a Member in 1956. He was a Fellow of the Chartered Institute of Secretaries.

THOMAS LYDWELL ECKERSLEY

Thomas Lydwell Eckersley, B.A., B.SC., PH.D., F.R.S., who died on the 15th February 1959 was born on the 27th December 1886. He was a grandson of Thomas Huxley and a brother of Roger and Peter Eckersley. His early childhood was spent in Mexico, but he was educated at Bedales School and at University College London. Then followed several years at the National Physical Laboratory before he went to Trinity College, Cambridge, to study mathematics. He was an inspector with the Egyptian Government Survey in 1913–14.

It was during the 1914–18 War, with his work on night-effect and coastal refraction, that he laid the foundations of his subsequent career with the Marconi Co. which was to establish him as one of the foremost scientists in radio research. His major contributions were in the theory of ground-wave and ionospheric propagation and in his pioneer work on scattering, but his interests were very wide for in addition to his mathematical ability he was well versed in modern physics.

He was a familiar figure at international conferences, having attended most of the C.C.I.R. and U.R.S.I. assemblies between the wars.

He was unassuming by nature and did not seek recognition. It was typical of him that he never proceeded to his M.A. He was finely built and was a keen player of hockey and tennis. Though not a musician he found great pleasure in listening to the playing of his wife who is a notable pianist and composer.

It was a great tragedy that his work was prematurely cut short by the paralysis which slowly incapacitated him. It was however mitigated by the courage and fortitude with which he fought his illness. He remained at work throughout the Second World War and continued to work at home after he had been forced to retire in 1946, even when he was almost entirely confined to bed. His life was undoubtedly prolonged by the devotion of his wife whose courage and cheerfulness were a source of inspiration to all who visited him.

He is survived by his widow, a son and two daughters.

He published many papers including 'An investigation of transmitting aerial resistances', 'Short-wave wireless telegraphy', 'The design of transmitting aerials for broadcasting stations', 'An investigation of short waves', and 'Studies in radio transmission', for which he was awarded the Duddell Premium in 1922, 1927, 1929 and 1932 respectively. He was awarded the Wireless Premium in 1925 for the report written jointly with Capt. H. J. Round, K. W. Tremellen and F. C. Lunnon on 'Measurements made on signal strength at great distances during 1922 and 1923 by an expedition'

sent to Australia'. He was awarded the same premium again in 1937 for his paper entitled 'Ultra-short-wave refraction and diffraction' and the Kelvin Premium in 1940 for his paper entitled 'Analysis of the effect of scattering in radio transmission'. All these papers were published in the *Journal*.

The calibre of his scientific achievements was acknowledged by his election as a Fellow of the Royal Society in 1938 and the award of a Fellowship of the Institute of Radio Engineers in 1946 and of the Faraday Medal in 1951.

He joined The Institution as a Member in 1937. G. M.

JOHN GEORGE LUCAS

John George Lucas who died early in 1959 was born on the 10th March 1873. He received a boarding-school education followed by a three-year course at Blackburn Technical College.

He joined the Post Office in 1900 and will be remembered for his pioneering work in the engineering department in connection with power supply to telephone exchanges.

In his early years he had been the person to whom the Post Office looked for advice about primary cells, then used in huge quantities for c.b.s. and magneto exchanges. In the 1920's small c.b. and automatic exchanges were installed in large numbers, and it was his job to standardize the many forms of secondary-cell power plant; these included petrol and gas engine units and even wind-driven generator sets at places not then served by mains electricity. He was concerned with the earliest experiments in this country on using metal rectifiers for battery-charging purposes. Under his guidance the Post Office engineering department pioneered the standardization of plate sizes for lead secondary cells, these later being the basis of the B.S.I. standard sizes.

He was a man of tremendous vitality and unusually wide practical interests, and on his retirement in 1933, having attained the position of assistant staff engineer, he applied these characteristics to the full in building up in a remote hamlet in Essex a very satisfying enjoyment of the delights of the countryside.

He joined The Institution as a Member in 1924. H. C. J.

ARTHUR BENJAMIN MALLINSON

Arthur Benjamin Mallinson who was born at Prestwich, near Manchester, on the 26th February 1878 died on the 18th April 1959. He was the younger son of Benjamin Mallinson who founded the timber firm of Mallinson and Eckersley in 1868. He did not join the family business in his early days but trained as an engineer at the Manchester School of Technology, followed by practical experience with the Ediswan United Electric Co. and a five-year apprenticeship with Mather and Platt.

In 1901 he joined Mather and Platt as assistant electrical contracts manager and worked on the electrification of collieries and paper mills in this country and in Portugal and on the Runcorn transporter bridge. In 1911, on the death of his father, he joined the family business and started in practice as a consulting engineer, chiefly in the textile and paper industries. In 1920 he also became engineering director of Mazapil Copper Co. and of the Coahuila and Zacatecas Railway, Mexico, which he visited on several occasions.

During the recent war he acted as adviser to the Ministry of Supply on woodworking machinery.

In his youth he was a keen lacrosse player and oarsman, being a member of the Agecroft Rowing Club. In his later years his interests included bee-keeping, angling and active membership of the Wilmslow Green Room Society. He was a member of Wilmslow Urban District Council for nine years, being chairman in 1932.

He joined The Institution as an Associate Member in 1904 and was elected a Member in 1921. He served on the North-Western Centre Committee from 1922 to 1930, being honorary secretary from 1922 to 1925, vice-chairman in 1926–27 and chairman in 1927–28. His papers entitled 'Electric driving in the paper mill, on heat-economy lines' and 'Justifiable small power plants' were published in the *Journal* in 1921 and 1925 respectively. H. D.

CYRIL MARSINGALL-THOMAS

Cyril Marsingall-Thomas who died on the 3rd May 1959 after a short illness was born on the 24th June 1893. He was educated at Blundell's School and Edinburgh University, and after service in the 1914–1918 War in the East with the Duke of Cornwall's Light Infantry he took a first-class diploma at Faraday House and latterly was on the managing committee.

He held positions in Malaya, Greece, and Singapore as a chartered electrical engineer before joining the Air Ministry Directorate of Works as mechanical and electrical engineer, in which capacity he served for 22 years, retiring in 1958.

He is survived by his widow and two daughters.

He joined The Institution as a Student in 1920 and was elected a Graduate in 1925, an Associate Member in 1932 and a Member in 1949. H. B.

OSWALD LEONARD ROBSON

Oswald Leonard Robson, M.B.E., B.SC.(ENG.), who died suddenly on the 28th April 1959 was born at Ilford on the 8th April 1903. He was educated at Ilford County High School and at London County Council School of Engineering. This was followed by practical training with the British Electric Transformer Co. Ltd., Hayes, and part-time study at Regent Street Polytechnic. After four years with the company he became an assistant transformer designer.

In 1927 he joined the staff of Bruce Peebles and Co. as assistant chief transformer designer and continued his studies for the degree of B.Sc.(Eng.) which he took at London University in 1931.

Thereafter he held a number of positions in England until the outbreak of the Second World War in which he served with the Royal Engineers. He attained the rank of major and was appointed a Member of the Order of the British Empire for his work on bomb disposal. On demobilization he returned to Bruce Peebles as chief rectifier designer and in 1953 was appointed manager of the rectifier department.

He served as president of Edinburgh Electrical Society and took a keen interest in Christchurch (Episcopal) Trinity, being a member of the vestry and people's warden. His death came as a great shock to all who knew him. Of reserved disposition, he was a man of independent mind who never left anyone in doubt as to what he thought on any particular issue. He passed on, as he himself would have wished, in harness. He is survived by his widow and two daughters, one of whom is married and lives in England, the other living at home with her mother.

He joined The Institution as a Student in 1923 and was elected a Graduate in 1929, an Associate Member in 1931 and a Member in 1951. He served on the Scottish Centre Committee from 1955 to 1958. He was also a member of The Institution of Mechanical Engineers. J. H. P. DE V.

WILLIAM ROSS

William Ross, M.B.E., who died on the 9th June 1959 was born in Glasgow on the 9th January 1884. He was educated at Kent Road Public School, Glasgow, and was apprenticed to A. and J. Inglis, studying part-time at Glasgow Royal Technical College.

He joined Glasgow Corporation electricity department in 1906 as a shift engineer in Waterloo Street substation. After some years of substation service he was transferred to the generating stations and became deputy superintendent at St. Andrews Cross in 1914, becoming superintendent in 1921 with 29200kW of plant under his care. He was promoted to the position of generation superintendent in 1924 and was responsible for Port Dundas, St. Andrews Cross, and Dalmarnock which had five turbogenerators each of 18750kW rating and was one of the most advanced stations in service at that time.

Although not yet 65 years of age he exercised his option to retire on the 31st March 1948 after 42 years of service, but he was retained by the British Electricity Authority as senior executive officer until the 31st December 1948.

He was a man of kindly nature and forthright speech who expected his staff to carry out their duties without assistance or advice although this was never denied when asked for. His friends, and he had many, were never in doubt regarding his opinions. In his early days he was a keen motorist, being interested in the possibilities of the steam engine as an alternative to the internal-combustion engine. Always a fine swimmer, in his later years he became interested in bowling and spent many hours at this pastime.

He joined The Institution as an Associate Member in 1920 and was elected a Member in 1938. He was appointed a Member of the Order of the British Empire in 1949. J. H.

THOMAS SHERRATT

Thomas Sherratt who died on the 21st November 1958 after a long illness was born on the 19th June 1887. He was educated at Saltley College School, Birmingham, and part-time at Birmingham Technical College while receiving practical engineering experience with the National Telephone Co.

He was employed by this company as a test clerk for seven years before he joined the patent department of the Relay Automatic

Telephone Co. as a technical assistant. His service with the latter concern was broken by a period in the Post Office telephone department in 1913 and in the R.N.V.R. as a paymaster sub-lieutenant during the 1914–18 War.

In 1931 he became technical assistant in the patent department of Siemens Bros. and in 1936 transferred to Carpmaels and Ransford in the same position. He subsequently took over all telephone-communication work until his retirement in 1957.

He was a very charming and admirable man, always straightforward and forthright, gentle and polite in his manner, address and speech, although quite capable of dealing with any difficult situation in the most appropriate manner, and an extraordinarily good judge of his fellow beings. He had a keen sense of humour and fun, likely to be expressed at any time. He was a keen Freemason. He was predeceased by his wife.

He joined The Institution as an Associate Member in 1918 and was elected a Member in 1930.

HAROLD MACKNIGHT SILLAR

Harold MacKnight Sillar who was born at Kingsland, Shrewsbury, on the 13th June 1874 died at Norwich on the 27th February 1959. He was educated at Dulwich College and apprenticed to Gow Wilson and Stanton, tea importers, London, studying part-time at Battersea Polytechnic and the Northern Polytechnic. He emigrated to British Columbia in 1893 and was a pupil with the Salt Construction Co., Vancouver. In 1895 he returned to London as an assistant engineer to R. F. Venner and Co.

Further experience in the distribution of electricity with the Vestry and Borough of St. Pancras and the Great Central Railway led to his appointment as distribution engineer to Belfast City Council in 1902. In 1904 he became chief mains superintendent of the Yorkshire Electric Power Co. at which time the company was commencing operations, and he held that position until he joined the Hendon Electric Supply Co. Ltd. in 1911. He was appointed resident engineer of this distribution concern in 1923, and he remained with them until his retirement in 1939, the company having passed into the ownership of the Northmet Power Co.

Engaged as he was in the formative years of some undertakings he had been inoculated with the principle that expansion must be financially rewarding. He found it easy therefore to accept the exposition of his managing director, K. A. Scott Moncrieff, that cables were revenue-earning but underground disconnecting boxes were not. But no one enjoyed better than he the escape route that was open to him by employing an above-ground pillar when technical considerations demanded such ingenuity. His office method and belongings illustrated his conviction that financial success came to men in small and bare offices.

He was a great lover of walking. For many years he derived much pleasure from voluntary work on the local committee of the Court of Appeal for Further Public Assistance Allowance and took an interest in gardening and horticultural matters. When about 60 years of age he studied and mastered Italian so that he might more fully enjoy his annual holiday in Italy. He is survived by his widow, a son and a daughter.

He joined The Institution as an Associate Member in 1900 and was elected a Member in 1926. S. W. H.

JAMES FRADSALL SMITH

James Fradsall Smith, B.SC.(ENG.) who died on the 6th April 1959 after a brief illness was born at Cardiff on the 12th June 1902. He was educated at Gladstone Elementary School and at Howard Gardens Secondary School, Cardiff. He received his technical training in electrical and mechanical engineering at the University of Wales and at the South Wales and Monmouthshire School of Mines concurrently with practical experience at Penrikyber Navigation Colliery. On the completion of these studies he graduated B.Sc. at the early age of 19.

After three years' experience as technical assistant to the chief electrical engineer of the Powell Duffryn Steam Coal Co. Ltd. he joined Kane and David, consulting engineers, Cardiff, as a technical assistant. In 1930 he entered the electricity supply industry as power business engineer to the South Wales Electric Power Co., St. Mellons. On the nationalization of the industry he was appointed chief commercial engineer to the South Wales Electricity Board, a position which he occupied with distinction up to the date of his untimely death.

He had many excellent qualities, not least of which were his humanity and kindly nature, and for these he will long be remembered with affection by his colleagues. He was a keen Rotarian of nearly 15 years' standing, and he was a great devotee of caravanning. His skill as a fisherman and in colour photography were well known in electrical circles throughout and beyond South Wales. He is survived by his widow and a daughter.

He joined The Institution as an Associate Member in 1936 and was elected a Member in 1949. He was also a member of the South Wales Institute of Engineers and of the South Wales Branch of the Association of Mining Electrical and Mechanical Engineers. H. J.

EDWIN GUNNAR F. SWANGREN

Edwin Gunnar F. Swangren who died on the 2nd January 1959 after a short illness was born on the 5th May 1895 at Haugesund, Norway.

He served an apprenticeship with T. B. Dowson and Co., South Shields, and attended Rutherford Technical College for his engineering education. In 1914 he joined the North Eastern Electric Supply Co. Ltd. and, after service in various capacities at power stations and elsewhere, in 1938 became the company's chief control engineer. He was closely associated with the design, operation and development of the company's control system.

On the nationalization of the electricity supply industry in 1948 he was appointed engineer in the Wear Sub-Area of the North Eastern Electricity Board. He remained in this position until the beginning of 1954 when he was finally promoted assistant chief engineer (operation and maintenance) at the board's headquarters, Newcastle upon Tyne, which post he held until his retirement at the end of 1958.

Of a quiet and unassuming nature he was very fond of sea sailing. He was also very interested in music and played the violin. He is survived by his widow, a son and a daughter.

He joined The Institution as an Associate Member in 1936 and was elected a Member in 1951. He served on the North-Eastern Centre Committee from 1946 to 1949 and from 1950 to 1953. He was also a member of The Institution of Mechanical Engineers. H. E.

ALBERT CARL UNBEHAUN

Albert Carl Unbehaun who died on the 18th April 1959 was born on the 5th November 1875 in Sydney, New South Wales. He was educated at Prince Alfred College, Adelaide, South Australia; and after five years' instruction under Prof. Bragg at Adelaide University, in 1894 he founded Unbehaun and Johnstone Ltd., Adelaide, taking E. A. Johnstone into partnership in 1896. In 1904 he moved to Western Australia and there established Unbehaun and Johnstone (W.A.) Ltd. He retired in 1937 and spent the remainder of his life experimenting with various forms of heating element.

He was keenly interested in atomic power and television; but unfortunately in his 83 years of life, of which 55 were spent in Western Australia, he did not have the opportunity of seeing either in practical form. He was a life member and patron of the Claremont Bowling Club. He is survived by his widow, two sons and two daughters.

He joined The Institution as an Associate in 1899 and was elected a Member in 1925. J. B. J.

JOHN HENRY WATERS

John Henry Waters who was born on the 13th January 1892 died at Wimborne, Dorset, on the 9th March 1959. He was educated at Westminster City School and attended Finsbury Technical College for three years where he obtained both mechanical and electrical engineering certificates of the City and Guilds of London Institute.

In 1911 he commenced work in the Wednesbury Corporation electricity department, joining the Bedford Corporation electricity department in 1914 as mains engineer. He served in the Royal Engineers in the 1914–18 War and was for some time a prisoner of war in Germany. On demobilization he returned to Bedford, serving with the corporation until 1919 when he joined the mains department of the Calcutta Electric Supply Corporation. He was promoted mains superintendent in 1926 and after working as development officer from 1940 to 1943 was promoted chief engineer.

He retired from Calcutta in 1947 after several times acting as Agent for the corporation. In 1952 he was elected to the board of directors of the Calcutta Electric Supply Corporation in London and was a director until his death.

He married in 1928 but had no children.

He joined The Institution as an Associate Member in 1926 and was elected a Member in 1930. He served on the Calcutta Committee in 1944–45 and was chairman from 1945 to 1947. D. H. P. H.

SOME RECENT BOOKS

S. W. AMOS

PRINCIPLES OF TRANSISTOR CIRCUITS

NEW YORK: RIDER. LONDON: ILIFFE. 1959. 167 PP. 21S.

THE first two chapters are devoted to an explanation at a very elementary level of the physical principles underlying diode and transistor action. Quite apart from errors of fact which appear in them (e.g. that pure germanium is an insulator and that the electrons in an atom revolve round the nucleus at a speed that increases with rise in temperature) it is to be doubted whether such an unsophisticated treatment serves any useful purpose. Unless one is prepared to delve deeper than this, surely it is better to regard a transistor simply as a 'black box' with certain external electrical characteristics.

When the author goes on to describe transistor amplifiers he is on safer ground, and the chapters on common-base, common-emitter and common-collector amplifiers serve as a readable introduction to the subject. Algebra is kept within bounds, and intelligent use is made of numerical examples and curves of input and output impedances. Point-contact transistors are given nearly as much attention as junction transistors, and there is little discussion of the relative merits of the two types of device.

Further chapters on matters such as bias stabilization, negative feedback and power amplification lead up to the design of a transistor superheterodyne receiver for use in the medium waveband. The remainder of the text is concerned with 'Other applications of transistors' (8 pp.) and 'Other types of transistor' (5 pp.)

In view of the restricted range of circuits considered by the author his title is misleading. The book itself should prove useful to those requiring a simple introduction to transistor receivers.

F. ANDÉ

DIE SCHALTUNG DER LEISTUNGS-TRANSFORMATOREN

BERLIN: SPRINGER-VERLAG. 1959. 332 PP. £3 10S. (APPROX.)

THIS work is intended for advanced students and for engineers practising in operational service, design, construction and administration. It includes a wealth of information not usually found in textbooks but is rather specialized since it deals only with connections, without reference to the actual arrangement of conducting and insulating materials or to the dynamic forces to which transformer windings are subjected in fault conditions.

After a brief introduction three sections cover fundamental concepts and 3-phase systems and their basic connections. One chapter each is devoted to single- and to 3-phase transformers. Connections of 3-phase transformers and connection groups are discussed in greater detail. Four sections examine transformers for interconnected networks, 3-winding transformers and transformers with tappings and those fitted with a changeover switch, e.g. for the single, double or cyclic interchange of phases or for the changeover from light to heavy load.

Two chapters consider the control of connection groups and in particular the determination of the 'Kennzahl' (the characteristic number indicating the phase angle of the respective connection group) and the control of phases in 3-phase power transformers; and two sections describe single- and 2-phase connections, e.g. the L-connection. There is a chapter on methods of current conversion, e.g. the Scott connection, and one on the V-connection. Four- and 6-phase connections are treated, and the last chapter surveys polyphase systems subdivided into those with open and those with closed interlinked connections.

The book is well produced and contains 248 nicely drawn figures, 104 useful tables, a brief bibliography and a subject index. A further volume on regulating transformers is envisaged.

J. B. BIRKS and J. H. SCHULMAN (*Editors*)

PROGRESS IN DIELECTRICS—VOL. 1

LONDON: HEYWOOD. 1959. 312 PP. £3 10S.

THE complicated phenomena of electric polarization, conduction and breakdown are being slowly elucidated with marked benefit to the design and life of electrical apparatus. This first volume of a proposed annual series records progress as seen by seven active workers in the field.

The subject of breakdown in solids, now understood in some detail, is well covered in a review which adds substantially, especially on industrial aspects, to the standard work by Whitehead, now some years out of date. The partial breakdown of crystals marked by a fascinating display of channels oriented along crystallographic directions is described for the first time in collected form by one of the earliest workers in this specialized field. Though seemingly academic this method may prove a unique tool for revealing the movements of conduction electrons in crystals.

A chapter on conduction and breakdown in liquids gives a clear picture of the tangle of effects depending on electrode-surface conditions, space charges, and dissolved impurities which still afflicts this subject and of the efforts which have been made to explain them. No more at this time could be expected. On gaseous breakdown the writer has not aimed at any full account of progress in theory but includes a discussion, useful to the engineer, of such electronegative gases as SF_6 used as gaseous insulation.

Until recently inorganic insulation has been limited mainly to metal-oxide systems, to the almost complete neglect of the more refractory carbides, nitrides and phosphides. Progress in the synthesis and use of these non-oxidic binary compounds is well reviewed. An article on ferroelectricity deals mostly with barium titanate but within this limit gives a full and lucid account of the subject. Finally an account of the nature of charged layers at interfaces and of the electrophoretic and similar effects which result from them is given elegantly and with a minimum of mathematics.

The work is essential reading for all physicists and engineers concerned with the interactions between matter and strong electric fields. To the electrical designer or the advanced engineering student the long chapter on the breakdown of solids will have an especially practical appeal. The volume is well produced at a reasonable price and is nearly free from misprints. If, however, blocks must be rotated from their intended orientation it would be better to choose one less

conspicuous than the first in the book. The statement (p. 305) that *ammonium* nitrate will decompose thermally to *aluminium* oxide is unsupported by experimental evidence and will convince only alchemists.

A. D. BOOTH, L. BRANDWOOD and J. P. CLEAVE

MECHANICAL RESOLUTION OF LINGUISTIC PROBLEMS

BUTTERWORTH. 1958. 306 PP. £2 10S.

THIS is a record of the remarkable efforts of the small but enthusiastic team of Birkbeck College towards mechanical translation. The use of a machine to translate one language into another was first suggested by Dr. Booth in a conversation with Warren Weaver, the Director of the Rockefeller Foundation, in 1946. This was followed in 1949 by a notable paper by Weaver on 'Translation' which gave issue to a spate of papers and a number of ambitious projects.

Though much handicapped by lack of hardware the team of Birkbeck College have played a noticeable part in this international venture. The optimism of the authors has left its mark on every page of this book. The sceptical reader will not be convinced that a translating machine which can dispense with an expert annotator of the original text and an equally expert decipherer of the somewhat moronic version supplied by the machine has now become a real possibility, but few people can fail to be impressed by the ingenuity of the authors.

After a historical introduction, a short explanation of calculating and data-processing machines, a section on stylistic analysis and a discussion of the general aspects of language translation, the programming technique for mechanical translation is described in what is perhaps the key chapter. The general rules are illustrated in a section on the mechanical transcription of Braille, followed by three chapters on French, German and Russian which will make difficult reading for anyone who has forgotten his grammar.

There are a few remarks on multilingual translation before the last section which deals with the technical details of a proposed translating machine. The cost is estimated at between £50000 and £100000 which is not great when compared with that of many of the giant electronic computers already operating; but the authors are not hopeful of obtaining financial support.

H. BROOKS (*Editor*)

ADVANCES IN SEMICONDUCTOR SCIENCE

LONDON: PERGAMON PRESS. 1959. 553 PP. £5

THIS is a collection of about 130 papers presented at the Third international conference on Semiconductors at the University of Rochester, U.S.A., in August 1958. They are grouped in the sessions in which they were delivered at the conference, and there is a résumé of the discussion which took place at each session. In addition there is an author index and a brief subject index.

The contributions deal with advanced theoretical and experimental work on the properties and behaviour of a variety of semiconductors. The emphasis is on fundamentals rather than on the application of semiconductors in devices. The list of authors includes nearly all the well known names in the semiconductor field; and although most of them are American papers were contributed by 14 countries. Britain gave 13 and Russia, Japan and France seven each. (Most of those by French authors appear in French.) The volume therefore can be regarded as covering the majority of the important work throughout the world.

Most of the papers were written by specialists for specialists, and for this reason the comments in the discussion are of particular interest. It is a pity that more books do not contain criticisms of the subject-matter. In addition to the specialized contributions there are excellent introductory and summary surveys.

The collection should be invaluable to those who wish to keep themselves up to date in basic semiconductor science.

(the late) L. H. A. CARR and J. C. WOOD

PATENTS FOR ENGINEERS

CHAPMAN AND HALL. 1959. 107 PP. 18S.

THE law of patents with special reference to engineering would not at first sight appear a likely subject for light reading; but the authors of this work have, by their simple and easy style, their frequent touches of humour and their selection of interesting examples, contrived to produce a quite remarkable combination of advice, instruction and pleasant reading out of a somewhat dry and certainly very complicated subject.

Without going into too much detail they cover the main principles of law and practice relating to patents; and it is well worth the while of any engineer to read the book, if only from the point of view of possible protection of his own interests.

If a criticism of such a readable and instructive volume has to be found it can only be that it is a pity that the authors did not treat the kindred subjects of registered designs, copyrights and trademarks at slightly greater length.

D. K. CHENG

ANALYSIS OF LINEAR SYSTEMS

READING, MASS.: ADDISON-WESLEY. 1959. 431 PP. £3 4S.

AN author who offers an introduction to linear differential equations, Fourier and Laplace transforms, feedback theory, and so on is covering well trodden ground. The main criterion of judgment is the degree to which his choice of material and detailed presentation match the needs and abilities of the students and junior engineers for whom the work is mainly intended.

Modern applied mathematics leans heavily on the theory of functions of a complex variable, and most similar volumes give a short account of it. Dr. Cheng contends however that a superficial knowledge of function theory is virtually useless and that students are better served by a treatment which goes as far as is possible without it. The competent mathematician will probably look on this as a retrograde step; nevertheless an account of inverse Laplace transforms (rational and irrational), Nyquist's criterion, and sampled-data transform methods in terms of more elementary concepts will be intelligible to a wider audience, and the book can be recommended to any reader who feels that this approach will help him.

In addition to the mathematical discussions cited there are chapters on electrical networks and electro-mechanical analogies.

Despite a few avoidable complexities the exposition is on the whole clear and the choice of details in each topic sound; there are many problems, to most of which answers are given.

N. CUSACK

THE ELECTRICAL AND MAGNETIC PROPERTIES OF SOLIDS

LONGMANS. 1958. 428 PP. £2 5S.

M. J. SINNOTT

THE SOLID STATE FOR ENGINEERS

NEW YORK: JOHN WILEY. LONDON: CHAPMAN AND HALL. 1958. 522 PP. £5

DURING the last 20 years a considerable part of the general research activity has been concerned with the properties of materials in the solid state. As a result of this activity entirely new industries and branches of industry have been created. These two volumes are attempts to fill the gap in textbooks on this subject suitable for students of different backgrounds and different levels of scientific attainment.

The first is written by a lecturer in physics at London University and is intended for students for special and honours degrees in physics and for those engaged on post-graduate research. It concentrates on the basic physics of many properties of great practical significance and does not consider applications. Intermediate mathematics is used freely, but no detailed knowledge of quantum mechanics is assumed. Familiarity with Maxwell's equations and the fundamental ideas of thermodynamics is however taken for granted.

The matters discussed are: electrical conductivity of metals and semiconductors; superconductivity; contact phenomena, thermionic and photoelectric emission; dia-, para-, and ferromagnetism; and dielectrics including ferroelectricity. The space devoted to the various topics has understandably been influenced by current examination syllabuses; and certain subjects of current interest, like gyromagnetic phenomena, thermoelectric power of semiconductors, and ferroelectricity, do not receive quite the treatment they deserve.

The book will be useful to the physicist, but it is not quite that wanted by engineers.

Prof. Sinnott writes for the engineer—to be more precise, for the engineering student rather than the practising engineer. He tries to acquaint the reader with the basic principles which underlie the behaviour of solid materials.

He begins with an account of the structure of atoms and their arrangement in solids, grouped in accordance with their bonds as: metallic, ionic, covalent and molecular. He considers the thermodynamic stability of the various solid phases and the rate processes by which changes between them occur. There are two brief chapters on crystallography and the diffraction of X-rays by crystals. The mechancial properties of polycrystalline materials are developed from those of single crystals, which are so much affected by deviations from the ideal crystal. The final chapters deal with thermal, electrical, magnetic and optical properties.

It is of course impossible for any one author to be equally conversant with all these topics; and it soon becomes apparent that Sinnott, who is professor of chemical and metallurgical engineering at Michigan University, feels more at home with phase diagrams and dislocation theory than with dielectric properties; it is only for the treatment of the former that one would recommend his work to the electrical engineer. A few interspersed numerical problems are useful in giving a feel for quantities. Glasses, a quite important class of engineering materials, are not covered. However, one may argue that they are supercooled liquids.

Both books contain useful bibliographies at the end of each chapter. The relative cost of these otherwise very similar volumes is indicative of the general difference in price of British and American publications, putting the latter out of reach of the average British engineering student.

E. FRANK

ELECTRICAL MEASUREMENT ANALYSIS

McGRAW-HILL. 1959. 443 PP. £3 8S.

ALTHOUGH undergraduates reading electrical engineering are generally taught electrical measurement as a main subject the syllabus is often crowded with descriptive matter, and it is almost impossible to devote sufficient time to training in experimental technique. As a result the acquisition of a sound technique and the development of an ability to assess data are normally left to the early postgraduate years.

This book is based on the idea that students should be carefully trained in analytical method, if necessary at the expense of art and design considerations; and having read it one cannot help feeling that this is the correct way to teach electrical measurement.

The first seven chapters deal with network analysis, galvanometer theory, errors in measurement and statistical analysis of experimental data. The following six chapters cover deflection and null methods of measurement, d.c. and a.c. bridge networks, non-sinusoidal waveforms, and the theory of rectifier and square-law instruments. The final chapter discusses the presentation of experimental data.

It is an excellent textbook for advanced courses. The analyses throughout are exhaustive and are supported by well chosen examples and a large number of problems with solutions. Teachers of this subject will find the author's approach stimulating, and his work is strongly recommended.

O. R. FRISCH (*Consulting Editor*)

THE NUCLEAR HANDBOOK

NEWNES. 1958. 640 PP. £2 10S.

IT is sometimes said that the Americans make this type of book much better than we in Britain. The reason is probably economic. This sort of publication can only do full justice to its subject if extended to a point where the cost is many times that of the above volume.

It consists of contributions from 22 specialists, mainly British, working in the field of nuclear physics. Despite its small size it contains much information both in tabular and in graphical form which will be of use to research workers, physicists, mathematicians and some engineers working on the fringe of the nuclear-reactor design field.

Scientists directly concerned with the nuclear-energy industry normally go straight to original sources of specialized information, and this compilation is not for them. Its chief market will be among those unable to afford the more expensive handbooks. It will have an appeal to engineers or research workers working in comparative isolation and requiring a point of departure for investigations in fields with which they are not entirely familiar and for which the relevant sources are not immediately available.

The sections on neutrons and nuclear reactions are well written and informative. The section dealing with reactors and reactor theory is rather thin on the ground, but the author is hardly to be blamed considering the space limitation. Beyond a brief mention in section 1–6 there is no information on thermonuclear reactions.

On the other hand one of the most valuable sections is that on electronics. It is a useful starting-point for a study of the subject as applied to atomic-energy projects, particularly in regard to radiation-detection instruments, and is very good value indeed.

One cannot expect a quart from a pint pot, but with this in mind one can say that the handbook will meet a genuine if limited need.

M. R. GAVIN and J. E. HOULDIN

PRINCIPLES OF ELECTRONICS

ENGLISH UNIVERSITIES PRESS. 1959. 348 PP. 30S.

BY this volume one is reminded of the expression 'one picture is worth a thousand words' since interspersed within the well written and concise text are some 600 diagrams. The result is that a wide field is soundly covered in a commendably easy-to-follow manner.

The bulk of the book is concerned with establishing the principles of the basic 'bricks' of all types of electronic apparatus involving circuits using thermionic valves, transistors and rectifiers in signal conditions of small or large sinusoids, transients and pulses. The frequent reference to operation in terms of load lines on suitable families of characteristics is most helpful in giving a clear understanding which is applicable regardless of signal amplitude.

Chapters are devoted to the subjects of feedback and noise. A sufficient knowledge of the basic physics is presented on electrons in matter, electron emission and electron motion to give confidence in considering the principles of transistors, cathode-ray tubes, magnetrons, klystrons and travelling-wave tubes. The enormous field of application is introduced to the reader by reference to techniques in circuitry, amplitude and frequency modulation and demodulation, automatic gain control, and so on.

The work deserves recommendation without reservation not only for its avowed purpose of satisfying students in the subject of electronics but also for the many scientific workers who in the use of electronic apparatus may need a sound understanding of basic principles.

E. V. D. GLAZIER and H. R. L. LAMONT

THE SERVICES TEXTBOOK OF RADIO. VOL. 5—TRANSMISSION AND PROPAGATION

H.M. STATIONERY OFFICE. 1958. 500 PP. 25S.

WHILE the seven volumes of this series have been written primarily to meet the needs of the three Fighting Services the theories and techniques are equally applicable in the civilian field, and gratitude is due to the Service authorities for making the series generally available.

As with the whole of the series this volume is intended to cater for three distinct classes of reader. It is for the beginner who has no prior knowledge of the subject; it is also for the technician; and finally it is for the more advanced reader; and an arrangement of the text has been devised which succeeds admirably in achieving the desired aim.

The first eight chapters contain a thorough and comprehensive discussion of transmission lines of various kinds including waveguides, the development sequence being from lines appropriate to low frequencies progressively through to those suitable for the highest frequencies now in use.

Chapter 9 presents the basic principles of radiation and is followed by four chapters on the basic theory of aerial elements and arrays and the types of aerial used in different parts of the radio spectrum. The final chapter deals with wave propagation; and while one chapter is obviously inadequate to give a comprehensive account of this wide field the authors have in fact succeeded in providing an extremely well balanced review of all the important aspects of the subject with the possible exception of ionospheric and tropospheric scattering. This is doubtless due to the fact that so much of the progress in the study of these phenomena has occurred since the text was prepared.

The work is excellently illustrated, and the presentation of the material is generally attractive; the appendices to the various chapters, which are designed for the advanced reader, are particularly suited to this end; and the book may safely be recommended as worthy of the attention of all communication engineers.

N. B. HANNAY (*Editor*)

SEMICONDUCTORS

NEW YORK: REINHOLD. LONDON: CHAPMAN AND HALL. 1959. 767 PP. £6

ALL the 17 authors of this monograph are associated with the Bell Telephone Laboratories and have made important contributions to their branches of the subject-matter during the last few years. They have here combined to produce a most stimulating work having characteristics between those of a textbook and those of a series of progress reviews. Although (perhaps because) the book has been written primarily for readers with a chemistry background specialists (and others) concerned with the physics and technology of semiconductor materials and devices will stand to gain considerably in breadth and depth of understanding by exposing themselves to its impact.

It must however be pointed out that while on the one hand the transistor specialist will encounter much that he has read elsewhere he will find detailed discussions of surface chemistry and of chemical and structural defects in crystals with which he may be less familiar. On the other hand there are chapters on the Group III–V intermetallic compounds, the II–VI compounds such as CdS, the properties of polycrystalline oxides and sulphides, and the electric (and some magnetic) properties of oxides of the transition metals; and there is an interesting section on the electric and some other properties of organic semiconductors such as naphthalene.

The volume is well produced and illustrated, and each chapter ends with an extensive bibliography. The index exceeds 14 pp., and several useful tables of basic data are included (though perhaps not all so easily found again) in the text.

W. H. HAYT

ENGINEERING ELECTROMAGNETICS

McGRAW-HILL. 1958. 328 PP. £3 6S.

THE author aims at introducing electromagnetic theory to electrical engineers, and he does this from the beginning in terms of vectors with a good measure of success. The approach is based on his teaching experience, and he has certainly achieved particularly in the early stages a nice, simple, direct exposition well supported by diagrams of a most helpful kind.

There are however already available many other texts of a similar character, some of which have been produced by the same publisher, and one wonders why it was felt necessary to introduce this new volume on such a well worn topic. It is true that there is commendable originality in part of the treatment, and a few of the applications discussed such as relaxation and iteration methods of field mapping are an innovation; but a large section of the material could not by its very nature depart far from the conventional.

There is nothing one can seriously criticize about the work, giving as it does a satisfactory grounding on which to build electrical engineering studies and serving at the same time to introduce the student to more advanced and complete treatises.

The shortcomings, such as they are, will be found in the rather sketchy discussion of applications of Maxwell's equations, as for example the important subject of skin effect.

Nevertheless, acknowledging the deliberate restriction of scope and limitation of appeal, the book should find a place side by side with the many others with which it is associated in this part of our literature.

A. van der ZIEL

FLUCTUATION PHENOMENA IN SEMI-CONDUCTORS

BUTTERWORTH. 1959. 168 PP. 35S.

PROF. van der Ziel's new work is very much in keeping with an earlier one entitled 'Noise' which dealt mainly with fluctuation phenomena in thermionic valves. Analysis, partly in terms of the physical phenomena responsible and partly in terms of electrical behaviour and circuit representation, again predominates over experimental methods and results—but not overwhelmingly so. The mathematical methods used are well summarized early on, as are some of the older theories. The much studied flicker noise in semiconductors (whose spectrum is characterized by an approximately inverse proportionality of power-per-unit-bandwidth and frequency) is investigated in some detail, and McWhorter's attempt to link it with field effects at surfaces is carefully presented. Brief accounts of noise in photoconductors and semiconductor resistors show that here there is still much to learn.

The second half turns to devices, beginning with shot noise in diodes; the collective approach (random diffusion and random generation and recombination) and the particle approach (random events) are given equal weight. The markedly different effects responsible for noise in the avalanche region are mentioned. An attempt is then made to represent the effects of shot noise in transistors by noise generators and to express their dependence on bias conditions, temperature and frequency. The author returns to flicker noise in these two devices, apportioning it between surface, leakage and channel noises. Finally low-noise circuits and noise in diodes used as modulators and parametric amplifiers are touched on.

Noise is a subject which greatly attracts a few engineers because of its fundamental importance in telecommunication; they will undoubtedly find much of interest here. The many other engineers who accept noise as a natural limitation to their endeavours should not pass by the book for it can help them to make the best of semiconductor devices wherever noise threatens their freedom of action. It was apparently published at record speed—the cause perhaps of a few minor typographical errors remaining—and is moderately priced.

L. MARTON (*Editor*)

ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS—VOL. 10

ACADEMIC PRESS. 1958. 320 PP. £4

THIS is now a well established annual series. It follows the form of the previous issues and consists of a number of review articles on a wide variety of topics coming within the scope of the title. The style, quality and form of these contributions are almost as varied as the subject-matter; for example W. G. Dow on Nonuniform d.c. flow in magnetically focused cylindrical beams starts at the beginning and works systematically through the theory as developed up to date. Although this covers the original work of a number of other authors it is good to have a systematic treatment of this topical matter.

On the other hand the article by E. Billig and P. J. Holmes on Defects in diamond-type semiconductor crystals is little more than a catalogue of published papers and although useful for reference purposes makes dull reading. J. Brown on Microwave optics provides excellent reading and a good if elementary introduction. The same can be said of W. L. Lawless on Developments in computer logical organization. Here however the author adds some views of his own on likely developments.

E. G. Rowe on Some aspects of tube reliability gives an impression of nostalgic memories of the heyday of the vacuum tube gradually giving way to its lively competitor, the transistor. J. E. Day is interesting and informative on Recent developments in the cathode-ray oscilloscope. Anyone who doubts that important advances have taken place in this widely used instrument cannot have compared a modern commercial high-speed oscillograph with the conventional design of ten years ago. Day's article will certainly remove any doubts.

The volume gives good value for money, and electronic engineers concerned with modern developments will want to have it available for consultation.

T. S. MOSS

OPTICAL PROPERTIES OF SEMI-CONDUCTORS

BUTTERWORTH. 1959. 279 PP. £2 10S.

THIS offering is well produced and contains 74 line diagrams and an index. There is a complete and well selected bibliography of about 800 references including papers published up to summer 1958.

The content divides naturally into two parts. The first 40% is devoted to the theory of the optical, magneto-optical and photo properties of semiconductors. The remainder is an account of the properties of the more important semiconductors from germanium to cadmium telluride. The latter part bears a family resemblance to the author's previous work on photoconductivity in the elements.

Dr. Moss has been actively engaged on research on the photo and other properties of semiconductors for over 10 years. If references to his own work appear to be rather frequent this is understandable. He writes in a direct, almost clipped style which achieves a high but not indigestible rate of information per page. Little background in the subject is assumed—most of the first two chapters appears in more expanded form in standard textbooks on optics—but the book is directed at physicists rather than electrical engineers. However it can be recommended to any serious student as authoritative, comprehensive and comprehensible.

W. E. PANNETT

RADIO ENGINEERING FORMULAE AND CALCULATIONS

NEWNES. 1959. 200 PP. 17S. 6D.

THE great majority of the material in this booklet is taken directly from the 'Radio and television engineers' reference book' published in 1954.

Despite the lapse of five years the many mistakes and misstatements in the original have reappeared in this publication and could be as annoying to the practising engineer as they will be misleading to the junior. Also misdirecting could be the first mention of the decibel where on p. 7 it is used to define voltage as well as power ratios without the necessary warning about the common misuse of a power-ratio unit in voltage problems.

Of the several diagrams containing errors Fig. 156 on p. 158 is pointless, inaccurate and misinforming.

This is not a volume which can be recommended.

E. OPENSHAW TAYLOR

NUCLEAR POWER PLANT

NEWNES. 1959. 184 PP. 30S.

THE chapter headings are: energy requirements and resources; nuclear physics; reactor physics; types of reactor; reactor engineering; control and instrumentation; and economics of nuclear power. There are four appendices.

The argument hangs together well, no gross errors are noticed, and a large amount of ground is covered within the compass of 180 pages and 54 figures. However the degree of compression is such that statements of fact often appear with very little support, and the reader who asks 'why' must seek the answers elsewhere. This defect could be mitigated by footnote references to the literature, and it is regrettable that no references of any kind are given. In spite of this the book must be rated a useful addition to the elementary literature on nuclear power.

F. VILBIG

LEHRBUCH DER HOCHFREQUENZTECHNIK—VOL. 2

AKADEMISCHE VERLAGSGESELLSCHAFT M.B.H. 5TH EDITION. 1958. 735 PP. £4

THE appearance of the fifth edition of Vol. 1 in 1953 seems to have attracted little attention in this country so it is perhaps not superfluous to say that the basic theory of radio-communication is contained in Vol. 1. It contains the material on quasi-stationary circuit analysis, lines, propagation phenomena, aerials, atmospheric noise and conventional valves.

Vol. 2 has chapters on amplifiers in which transit-time effects are negligible, oscillators and transit-time amplifiers, feedback, screening, rectification, modulation and demodulation, pulse modulation, control of fading, theory of amplitude limitation, and the clipping of speech. A brief appendix on masers is included. The treatment covers semiconductor devices as well as valves.

It is impossible to give more than an idea of the contents in this review. It suffices to say that the general level is a good deal more advanced than that of any similarly comprehensive Anglo-American text, especially on questions of high-quality transmission of intelligence, where the problems of meeting C.C.I.R. requirements are freely discussed. On the other hand the discussion of electron and semiconductor devices is less detailed. The book can be recommended to anyone studying the design of major communication systems.

D. A. WATKINS

TOPICS IN ELECTROMAGNETIC THEORY

NEW YORK: JOHN WILEY. LONDON: CHAPMAN AND HALL. 1958. 118 PP. £2 12S.

SHORT and readable, this book is based on a lecture course for graduate students who already have a working knowledge of electromagnetic fields and waves. It is not written for the novice, and the author deliberately has omitted much explanatory material which many readers will wish to fill in for themselves.

All the topics presented can be applied to the theory of microwave valves; thus the opening subject is the propagation of slow waves on periodic structures and on various types of helix. The theory of coupled modes is developed and used to evaluate the behaviour of several microwave amplifiers. The final chapter, which ends abruptly, briefly outlines the microwave properties of ferrite materials.

The discussion of 'forbidden zones' is incomplete and misleading. It should include remarks on the attenuated, as opposed to evanescent, waves which may exist in a forbidden zone. The concepts of negative power and backward waves are glossed over; they deserve more careful introduction because there is still considerable misunderstanding of them. Several typographical errors occur; in particular the diagrams of Figs. 3.22 and 3.24 are transposed.

The work should appeal to the microwave-valve engineer; certainly it will make him think again.

G. B. WELCH

WAVE PROPAGATION AND ANTENNAS

VAN NOSTRAND. 1958. 257 PP. £2 3S. 6D.

LIKE many before it this publication is the outgrowth of a series of lectures; not all such ventures are successful since often they provide little that is new and only retread old ground without bringing fresh light to bear on the subject-matter. While this criticism might be a little too strong for the work under review it is doubtful if the claim on the dust cover that it is an 'important fundamental text' could be substantiated. It would scarcely be of much use to the qualified engineer or advanced student, but the author's expressed aim is to write for less-mature readers.

Beginning with a general description of simple harmonic motion, wave motion, standing waves and transmission lines the author goes on to consider reflection, refraction, interference, diffraction and polarization, pointing out the correspondence between optical and radio phenomena. All this material, except perhaps the brief reference in chapter 4 to radio-wave refraction in the troposphere including the effects of inversions and ducts, has already appeared in other texts; and in this respect the present volume appears to have little to commend it over these. A rudimentary account of the properties of the ionosphere and an outline of the basic features of aerials, waveguides and propagation complete the book.

It is a pity that the author shares the insularity of many American writers: much of the text and all the references to literature for further study suggest that he is not aware of contributions to his subject by workers outside his own country.

**Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members*

LIBRARY ACCESSIONS

BOOKS

ANDÉ, F. 621.314.2

Die schaltung der leistungstransformatoren (Power transformer circuits)

Berlin: Springer-Verlag, 1959. pp. viii, 332. 24 × 16cm. £2 10s.

Describes the arrangements for connecting the windings of power transformers. This book is reviewed on p. 539.

ANTONI, C. P., and ANTONIU, I. S. 621.315.01

Behaviour of electrical machines under surge conditions

Romania: Academia Republicii Populare Romine, 1957. pp. 200. 22 × 15cm. 15s.

Deals with the causes of atmospheric discharges, the way surge conditions are produced and methods of impulse testing. The effects on transformers and rotary machines are considered.

ATTURA, G. M. 621.318.42

Magnetic amplifier engineering*

New York and London: McGraw-Hill, 1959. pp. xii, 220. 24 × 16cm. £2 18s.

A treatise on basic magnetic-amplifier theory which presents a consistent analytical method applicable to all types. This book will be reviewed in a future issue.

BIRKS, J. B., and SCHULMAN, J. H. (*General Editors*)

Progress in dielectrics—Vol. 1 537.226

London: Heywood, 1959. pp. ix, 312. 25·5 × 16cm. £3 10s.

The first of an annual series of volumes of critical surveys. Papers in this volume deal with dielectric breakdown in solid insulation, dielectric-breakdown effects in crystals, the electric strength and high-field conductivity of dielectric liquids, gaseous dielectrics, ferroelectricity of barium-titanate single crystals, non-oxide ceramic dielectrics and electrophoretic deposition of insulating materials. This book is reviewed on p. 539.

BLANC-LAPIERRE, A., GOUDET, G., and LAPOSTOLLE, P.

Électronique générale. 2nd edition 621.38

Paris: Eyrolles, 1959. pp. 504. 24·5 × 15·5cm. £5 5s.

Although it has a very general title this book is concerned mainly with electron theory, emission, electron optics and h.f. tubes including travelling-wave tubes and magnetrons.

CARROLL, J. M. 621.314.7

Modern transistor circuits*

New York and London: McGraw-Hill, 1959. pp. xii, 268. 29 × 22cm. £3 6s.

A series of articles originally published in 1956–58 in *Electronics*. This book will be reviewed in a future issue.

CATTERMOLE, K. W. 621.314.7

Transistor circuits*

London: Heywood, 1959. pp. x, 442. 22 × 14cm. £3 10s.

An introductory account of the theory, functions and circuit arrangement of transistors is followed by a comprehensive review of their applications in many types of circuits as amplifiers, switches, etc. and at various frequencies. To be reviewed.

CLAYTON, A. E. 621.313.04

The performance and design of direct current machines. 3rd edition*

London: Pitman, 1959. pp. xx, 516. 22 × 14cm. £2

Deals with the principles and practice of electrical design using the M.K.S. system. The section on control and special machines has been extended, the chapter on insulation has been brought up to date, and eddy-current losses in deep-armature conductors are now dealt with in a new chapter.

COOK, P. M., and McCRUM, A. W. 621.77

The calculation of load and torque in hot flat rolling

London: British Iron and Steel Research Association, 1958. pp. 109. 31 × 34cm. £2 5s.

A book of 96 large graphs with instructions for their use.

EICHNER, H., and HEIN, H. 40 = 30

Reading German for scientists*

London: Chapman and Hall, 1959. pp. xi, 207. 23 × 14cm. 30s.

Deals with those aspects of grammar which must be known in order to be able to read German as distinct from speaking or writing it. The illustrations and exercises are concentrated on the kind of basic vocabulary met in reading scientific German.

Chemistry and physics are the subject fields used. This book will be reviewed in a future issue.

ERICKSON, W. H., and BRYANT, N. H. 621.31

Electrical engineering theory and practice. 2nd edition

New York: John Wiley. London: Chapman and Hall, 1959. pp. xiii, 614. 24 × 15cm. £3 4s.

This work for non-electrical engineering students deals with a.c. and d.c. circuits and machines and electronic devices and equipment.

GAVIN, M. R., and HOULDIN, J. E. 621.38

Principles of electronics*

London: English Universities Press, 1959. pp. xii, 348. 22·5 × 14cm. 30s.

A general introduction to the subject suitable for a degree or diploma course in physics or electrical engineering. This book is reviewed on p. 542.

HANNAY, N. B. (*Editor*) 621.315.59

Semiconductors*

New York: Reinhold, 1959. pp. xxiii, 767. 23·5 × 15·5cm. £6

A comprehensive work on the physical chemistry and the fundamental physics of semiconductors. It discusses crystal growing, control of composition, the properties of some semiconductor materials, semiconductor surfaces and electrodes. This book is reviewed on p. 542.

HENRIET, P. 621.315.01

Fonctionnement et protection des réseaux de transport d'électricité (Operation and protection of electric transmission systems)

Paris: Gauthier-Villars, 1958. pp. 372. 25 × 16cm. n.p.

Reviewed in May 1959 *Journal*, p. 324.

HIGONNET, R. A., and GREA, R. A. 621.316.3

Logical design of electrical circuits*

New York and London: McGraw-Hill, 1958. pp. ix, 220. 24 × 15·5cm. £3 17s. 6d.

Deals with the application of Boolean algebra to the analysis of switching circuits for telephone systems, computers and the like in which mechanical and electronic relays are used. Reviewed in May 1959 *Journal*, p. 324.

HOLLINGDALE, S. H. 518.5

High speed computing methods and applications

London: English Universities Press, 1959. pp. xii, 244. 23 × 14cm. 25s.

An introduction to the subject is followed by an outline of the historical background. Two sequential machines Edsac and Deuce are described.

Storage devices and the logical design of computing circuits are briefly discussed before applications are dealt with. This book was reviewed in the August 1959 *Journal*, p. 478.

KATZ, H. W. (*Editor*) 537.226.3

Solid state magnetic and dielectric devices*

New York: John Wiley. London: Chapman and Hall, 1959. pp. xxi, 542. 24 × 15cm. £5 8s.

A detailed treatment of the theory and applications of solid-state devices and components with the exception of the transistor. Among the subjects covered are non-linear magnetic and dielectric materials, electromechanical applications, ferrites at microwave frequencies, magnetic and dielectric amplifiers, digital techniques and magnetic recording. This book will be reviewed in a future issue.

KRONIG, R. (*Editor*) 53

Textbook of physics. 2nd edition*

London and New York: Pergamon Press, 1959. pp. xiv, 961. 25 × 16cm. £4 4s.

Translation of a Dutch work which deals with mechanics, vibrations, electrodynamics and optics. The Giorgi system of units is used throughout.

KUH, E. S., and PEDERSON, D. O. 538.551

Principles of circuit synthesis*

New York and London: McGraw-Hill, 1959. pp. xiii, 244. 24 × 15·5cm. £3 6s.

A book for students concerned with communication circuits and control systems. It approaches the subject of circuit synthesis and classical filter theory by physical reasoning, assuming a knowledge of circuit analysis.

KULLBACK, S. 621.391

Information theory and statistics

New York: John Wiley. London: Chapman and Hall, 1959. pp. xvii, 395. 24 × 15cm. £5

An exposition of the basic concepts and properties of information measures with emphasis on the statistical aspects.

LANGSDORF, A. S. 621.313.2

Principles of direct-current machines. 6th edition*

New York and London: McGraw-Hill, 1959. pp. xvii, 363. 24 × 15·5cm. £3 6s.

Considers the operation and characteristics of generators and motors in terms of the relations between their magnetic and electrical circuits.

MILLER, W. E. 621.396.62

Radio circuits. A step by step survey. **4th edition**

London: Iliffe, 1959. pp. ix, 172. 22·5 × 14cm. 15s.

A simple explanation of each stage in a modern superheterodyne broadcast receiver.

MOLLOY, E. 621.315.3

Wiring circuits. 2nd edition

London: Newnes, 1959. pp. 231. 22 × 14·5cm. 12s. 6d.

Gives diagrams and brief explanations of domestic and industrial supply circuits; a variety of control circuits including alarms; and circuits for transformers, rotary convertors, rectifiers and charging equipment, lifts, cranes, heating and welding.

NEWSTEAD, G. 538.551

General circuit theory*

London and New York: Methuen, 1959. pp. vii, 144. 17 × 11cm. 15s.

Following an introductory chapter and one on general network theorems linear passive 4-terminal networks in the steady state are discussed. The development is then extended to networks not in the steady state with a final chapter on some extensions to non-linear theory. This book will be reviewed in a future issue.

RICKMAN, E. J., and ABBEY, S. 77

Electronic flash in principle and practice

London: Pitman, 1958. pp. vii, 176. 22 × 14cm. 28s.

Although mainly concerned with the applications of this new technique in photography the book includes an explanation of the principles of the electronic equipment, maintenance and fault tracing.

ROSENBERG, A. 413 = 82

Russian abbreviations: a selective list

Washington: Library of Congress, 1957. pp. ix, 513. 26 × 20cm. 24s. 9d.

A list of abbreviations of names, contractions and initials which are being extensively used in Russian newspapers and periodicals.

SCOTT, W. T. 537

The physics of electricity and magnetism

New York: John Wiley. London: Chapman and Hall, 1959. pp. xvi, 635. 24 × 15cm. £3 10s.

Gives a detailed explanation of the basic theory using a modern atomic approach. The treatment combines the descriptive and mathematical employing vector notation and intermediate calculus.

SISKIND, C. S. 621.313

Electrical machines; direct and alternating current. 2nd edition*

New York and London: McGraw-Hill, 1959. pp. ix, 563. 24 × 15·5cm. £3 2s.

Deals with the principles, applications and operation of machines, transformers, rectifiers and control gear and contains worked examples and questions to be answered by students.

SLUCKIN, W., and GREENER, J. R. 538.55

Principles of alternating currents. 2nd edition (Vol. 3)

London: Cleaver-Hume, 1959. pp. 338. 19 × 12cm. 15s.

A simple treatment of the theory of alternating-current work. Machinery is dealt with in Vol. 4 of this series, but the transformer is considered in this volume. The practical application of fundamental principles is indicated by references to transmission, distribution and utilization problems. In the present edition the M.K.S. system is used.

SMULLIN, L. D., and HAUS, H. A. (*Editors*) 621.396.8

Noise in electron devices*

New York: John Wiley. London: Chapman and Hall, 1959. pp. xvi, 413. 24 × 15·5cm. £4 16s.

A discussion of the mathematical theory and physical phenomena rather than of design techniques. It covers noise due to thermionic emission, the general circuit aspect of noise in microwave tubes, problems in the design of low-noise travelling-wave tubes and space-charge control tubes, semiconductor noise and low-noise transistor circuit design. This book will be reviewed in a future issue.

STARR, A. T. 621.3(076)

Whittaker's arithmetic of electrical engineering for technical students and engineers. 5th edition

London: Pitman, 1958. pp. vii, 200. 19 × 12·5cm. 10s.

A collection of worked examples and exercises on Ohm's law, the Wheatstone bridge, electrostatics and electromagnetism in which the M.K.S. system is used.

TAYLOR, E. O. 621.039

Nuclear power plant*

London: Newnes, 1959. pp. vii, 184. 22 × 14cm. 30s.

Gives a concise account of present and future world energy resources and requirements followed by chapters on nuclear and reactor physics. Types of reactor, their engineering, instrumentation and control and also the economics of the subject are described. This book is reviewed on p. 544.

WAKEFIELD, G. G. (*Editor*) 629.135

Aircraft electrical engineering*

London: Chapman and Hall, 1959. pp. xiv, 349. 25 × 16cm. £2 10s.

Based on a series of lectures by experts. Special attention is given to environmental conditions including brush wear at high altitudes and to functional requirements. This book will be reviewed in a future issue.

WHITE, G. K. 536.48

Experimental techniques in low-temperature physics

Oxford: University Press, 1959. pp. viii, 328. 22·5 × 14cm. £2 5s.

Deals with the production and measurement of low temperature, handling liquefied gases on the laboratory scale, and the principles and some details of the design of experimental cryostats including the problems of heat transfer and temperature control. Includes relevant physical data.

ZIMMERMANN, H. J., and MASON, S. J. 621.385

Electronic circuit theory: devices, models and circuits*

New York: John Wiley. London: Chapman and Hall, 1959. pp. xvii, 564. 24 × 15cm. £4 6s.

Gives methods of analysing electronic circuits by using resistive models for diodes, triodes, pentodes and transistors. Graphical interpretations of signal operation are described. This book will be reviewed in a future issue.

OTHER PUBLICATIONS

ANDLAW, E. V.

Some aspects of the scheme of development of the electricity supply of the City Council of Gibraltar

Gibraltar: 1959. pp. 30. 32·5 × 21cm. n.p.

ASSOCIATION SUISSE DES ÉLECTRICIENS

Encyclopédie des isolants électriques (Encyclopedia of electrical insulating materials)

Zürich: Association Suisse des Électriciens, 1958. pp. 80. 30 × 21cm. £1 16s. 8d.

BRITISH BROADCASTING CORPORATION

The Crystal Palace Band I television transmitting aerial by W. Wharton and G. C. Platts

Engineering Monograph No. 23

London: B.B.C., 1959. pp. 15. 28 × 22cm. 5s.

The measurement of random noise in the presence of a television signal by L. E. Weaver

Engineering Monograph No. 24

London: B.B.C., 1959. pp. 16. 28 × 22cm. 5s.

A quality-checking receiver for v.h.f. f.m. sound broadcasting by G. G. Mayo and R. E. Jones

Engineering Monograph No. 25

London: B.B.C., 1959. pp. 15. 28 × 22cm. 5s.

BRITISH INSTITUTE OF RADIOLOGY

Recommendations of the International Commission on Radiological Protection

British Journal of Radiology Supplement No. 6

London: British Institute of Radiology, 1958. pp. x, 94. 25 × 18cm. 10s. 6d.

COMITATO NAZIONALE PER LE RICERCHE NUCLEAR

Un piano quinquennale per lo sviluppo delle ricerche nucleari in Italia (Five-year plan for the development of nuclear research in Italy)

Rome: Comitato Nazionale per le Ricerche Nucleari, 1958. pp. vii, 457. 25 × 17cm. £1 15s.

COMITÉ CONSULTATIF INTERNATIONAL TÉLÉPHONIQUE

18th Plenary assembly, Geneva 3rd–14th December 1956. Vol. 3 bis of the Green Book—Line transmission maintenance

Geneva: International Telecommunications Union, 1958. pp. 307. 26·5 × 17cm. n.p.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

The calculation of the median sky wave field strength in tropical regions by W. R. Piggott

Radio Research Special Report No. 27

London: H.M.S.O., 1959. pp. 38. 24 × 15cm. 2s. 6d.

GENERAL POST OFFICE

Third report of the Mobile Radio Committee

London: H.M.S.O., 1959. pp. 21. 24 × 15cm. 1s. 3d.

GEOPHYSICS RESEARCH DIRECTORATE—AEROPHYSICS LABORATORY

Recent advances in atmospheric electricity. Proceedings of the Second conference on Atmospheric electricity held at Portsmouth, New Hampshire, 20th–23rd May, 1958, edited by L. G. Smith

London and New York: Pergamon Press, 1958. pp. xv, 631. 25·5 × 19cm. £6

INTERNATIONAL CONFERENCE ON LARGE ELECTRIC SYSTEMS (C.I.G.R.É.)

Proceedings of the 17th Convention, 4th–14th June 1958—Vol. 3

Paris: Conference Internationale des Grands Réseaux Électriques, 1959. pp. 1515. 24×16cm. n.p.

NATIONAL ACADEMY OF SCIENCES
NATIONAL RESEARCH COUNCIL

Digest of literature on dielectrics. Vol. 21—1957 Edited by J. Hart and R. A. Soderman

Publication 599

Washington: National Academy of Sciences, 1958. pp. xii, 283. 28 × 22cm. £2

Annual report 1958. Conference on electrical insulation

Washington: National Academy of Sciences, 1959. pp. vi, 57. 28 × 21·5cm. £1 1s. 6d.

NATIONAL PHYSICAL LABORATORY

MSF: new programme of experimental standard frequency transmissions from the United Kingdom commencing 26th May 1953

London: D.S.I.R., 1953. pp. 5. 24 × 15cm. n.p.

ORGANISATION FOR EUROPEAN ECONOMIC CO-OPERATION

Basic statistics of energy for O.E.E.C. countries, 1950–1957

Paris: O.E.E.C., 1958. pp. 55. 32 × 24cm. 7s.

ROYAL SOCIETY

BRITISH NATIONAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR

Some International Geophysical Year achievements. An interim statement issued at the close of the observational phase of the International Geophysical Year

London: Royal Society, 1958. pp. 16. 21·5 × 16·5cm. n.p.

UNITED NATIONS

Proceedings of the Second United Nations international conference on the Peaceful uses of atomic energy. Geneva 1–13 September 1958. Vol. 8—Nuclear power plants, Part 1

Geneva: United Nations, 1958. pp. viii, 584. 28 × 22cm. £5

Proceedings of the Second United Nations international conference on the Peaceful uses of atomic energy. Geneva 1–13 September 1958. Vol. 12—Reactor physics

Geneva: United Nations, 1958. pp. ix, 767. 28·5 × 22cm. £6 12s.

Proceedings of the Second United Nations international conference on the Peaceful uses of atomic energy. Geneva 1–13 September 1958. Vol. 15—Physics in nuclear energy

Geneva: United Nations, 1958. pp. ix, 476. 28 × 22cm. £4 9s.

Proceedings of the Second United Nations international conference on the Peaceful uses of atomic energy. Geneva 1–13 September 1958. Vol. 31—Theoretical and experimental aspects of controlled nuclear fusion

Geneva: United Nations, 1958. pp. vii, 390. 28 × 22cm. £5 6s.

Proceedings of the Second United Nations international conference on the Peaceful uses of atomic energy. Geneva 1–13 September 1958. Vol. 32—Controlled fusion devices

Geneva: United Nations, 1958. pp. vii, 465. 28·5 × 22cm. £5 6s.

ECONOMIC COMMISSION FOR EUROPE

Rural electrification—Vol. 3

Geneva: United Nations, 1958. pp. 176. 28 × 22cm. 11s.

UNITED STATES—NATIONAL BUREAU OF STANDARDS

On the theory of fading properties of a fluctuating signal imposed on a constant signal by H. Bremmer

N.B.S. Circular 599

Washington: United States Department of Commerce, 1959. pp. iii, 32. 26 × 20cm. 2s.

Elections and transfers

The following elections and transfers approved by the Council are effective from the 1st July 1959

ELECTIONS

Associate Members

BEACHAM, Frank Stanley
BLUNDELL, Capt. Edward Alan, O.B.E., R.N.
BOYD, Ronald Mills, B.SC.
CHU, Min Son, B.SC.
COOKSEY, Maurice
DENSEM, Ivan Ryland
DIXON, Walter
DOUGLAS, Lt.-Cmdr. Walter Harry Brookes, B.SC., R.N.
FOSTER, Ivan Rolce, B.E.
GODDINGS, Denys Barry
HAN, Man Choon, B.E.
JERMY, Peter Valentine, B.SC.(ENG.)
MOULL, William Crawford, B.A.SC.
PENNINGTON, Sqdn.-Ldr. George Hall, B.SC., R.A.F.
PRESSDEE, Lt.-Cmdr. Albert William, B.SC., R.N.
ROBERTS, David Harri, B.SC.
SCANNELL, Ove Ahnfeldt, B.E.
WALBRIDGE, Edward Ernest
WHITE, Alan
WHITTAKER, William Cecil Gilbert
WOOD, William Stanley

Associates

BARNES, Harold
BECKLEY, Donald James
KNIGHT, Charles Kenneth
MUNRO, Hugh Gardner
SHARP, John Alex
TAIT, William Frederick
WADE, Eric
WERNINCK, Ernest Hope

Companions

SMELLIE, James
WAINE, Fred

TRANSFERS

Associate Member to Member

ACKROYD, Ronald Tunstall, M.ENG., PH.D.
ADLINGTON, Leonard
AMER, Donald Foster
BAKER, Herbert William
BUNCE, Leonard Cecil, B.SC.
GRIFFITHS, Eric William Sydney, M.A.
KANGA, Dorab Pestonjee Maneckjee, M.SC.TECH.
LUMLEY, Ernest Plaxton
NELL, Ronald Aaron, B.SC.(ENG.)
OAKESHOTT, David Francis, B.SC.
ST. JOHNSTON, Andrew, B.SC.
SMITH, John
SPEARMAN, Felix Robert James
TUNNICLIFF, Eustace, M.SC.
VIRKAR, Dattatraya Vishnu, B.E.
WHITE, Samuel Henry

Graduate to Associate Member

ADIBI, Mahmood, B.SC.
ANDREW, Thomas Edward
ANTHONY, James Kent Farmer
BATES, James John, B.SC., PH.D.
BAYLIS, Herbert Wilfred
BHAGWAT, Prabhakar Gopalrao, B.SC.(ENG.)
BIRTLES, Joseph
BLAKEMORE, John Frederick
BRIDGE, William

Graduate to Associate Member (continued)

BURFORD, Samuel William Harold
BURKE, Peter Hugh Wyndham
BURTON, Allen Ernest, B.E.
CANHAM, Jennifer June Drayson, B.SC.(ENG.)
CHAKKO, John Mazhuvancheri, D.F.H.
CHARNOCK, Howard Dennis
CHURCHYARD, Eric Basil
CLARKE, Alfred David
CLOSE, Dennis
COHEN, Emanuel, M.SC.
CRAVEN, Dennis John
CRAWFORD, Frederick William, M.SC., PH.D.
CRETCHLEY, Ronald Richard, B.SC.(ENG.)
CUDWORTH, James
DAVIES, Eric Hywel Royston
DE JONG, Peter
DENISON, Geoffrey Stephen
EASTWOOD, Joe Patrick
EVANS, Leonard Duncan
EVE, Godfrey Arnold
FLETCHER, Charles Gordon
GAIR, Frederick William
GARRETT, Charles Reuben, D.L.C.
HALKYARD, Harold Lees, B.SC.
HARDY, Ernest Colin, D.L.C.
HARTLEY, Hargreaves, B.SC.(ENG.)
HAYWARD, Raymond Hilton
HETHERINGTON, Dennis Wilson
HICKS, Anthony, B.SC.
HOLMES, Thomas William
HOWITT, Phillip David
HUGHES, Fred
HUNNIBELL, Eric James
JAHN, Michael Hermann, B.SC.
JAMES, Cyril Percy Nally
JARDINE, John, B.SC.(ENG.)
JUREK, Stefan Franciszek Leopold, B.SC.(ENG.)
KEMP, Alan
LANE, John
LEE, Arthur William
LOUNSBACH, Anthony George
LOVE, John
LUCAS, Alan John Empson
McWHIRTER, Ian
MAIN, Percival Henry, B.SC.(ENG.)
MARRACK, Richard
MARSHALL, Michael Ernest Malory
MAWSON, Hartley
NORTHEN, William Patrick, B.A.
PARRY, Jeffrey John
PETERS, Norman
PINKNEY, Desmond Reynolds
PITCHES, Brian Edward, B.SC.
PRINCE, George Edwin
RALPH, George
RIMMER, John Herbert, B.ENG.
ROGAL, Barry, B.SC.
ROTHWELL, Denis, M.A.
SANGER, Donald Charles Cornford
SCOTT, Edwin
SNAZELL, George Edward, B.SC.
SPARKES, Geoffrey Thomas
SPEED, Ernest
STUART, Robert Dennis, M.A. PH.D.
SWEETENHAM, Walter Maggs, B.SC.
TIMMS, George Edward
TOMSETT, Leslie Frank
TRAPPE, Patrick Brendan, B.E., B.SC.
VALENTINE, John
WAKEFIELD, James Roger
WALKER, Charles Willis
WALSH, Patrick, B.E.
WARINTON, Derek Maurice
WIDDICKS, Jon Anthony, B.SC.(ENG.)
WILKINS, Colin Bernard, B.SC.(ENG.)
WILKINSON, Ernest Lincoln George B.SC.
WILLCOCK, Lt.-Cmdr. Cecil Blackwood, M.A., R.N.
WILSON, Philip Norman
WOODS, Alexander Samuel

Student to Associate Member

LIVERSEDGE, Peter, M.A.

British Nuclear Energy Conference

THE British Nuclear Energy Conference was established in 1955 by The Institutions of Civil, Mechanical, Electrical and Chemical Engineers and The Institute of Physics. It is a collaborating and co-ordinating rather than a controlling body, and it is true that the inelegant word 'consortium' would have defined it more clearly. Its object is the advancement and dissemination of knowledge covering the applications of nuclear energy and ancillary subjects. The Conference obtains papers dealing with the theory and practice of the control and use of nuclear energy and arranges for their presentation and publication; and it promotes meetings, symposia and conferences on a national and international basis.

General meetings sponsored by the individual constituent societies (now increased to 12) are also included in the programme of the B.N.E.C. The societies arrange for the presentation of papers relevant to their own particular aspects of nuclear energy, and members of any of the 12 societies may attend and participate in meetings so sponsored.

The Conference publishes the *Journal of the B.N.E.C.* four times a year. It contains papers presented and discussions arising at meetings of the Conference and of the constituent societies and provides between two covers a complete record of all the significant developments in the field of nuclear energy.

The April 1959 issue of the *Journal of the B.N.E.C.* contains the seven lectures presented at the Symposium on 'Geneva, 1958' arranged by the B.N.E.C. and held in London on the 13th March 1959. These lectures review and assess developments in those sections of the 2nd United Nations international conference on the Peaceful uses of atomic energy held in Geneva in 1958 which are deemed to be of interest to the members of the B.N.E.C.

In the first lecture, entitled 'Geneva, 1958', Sir John Cockcroft gives a general account of the conference. He refers to nuclear power stations in Britain, the United States, the Soviet Union and France; the economics of nuclear power; ship-propulsion units; controlled-fusion projects; fundamental nuclear physics; and nuclear particle accelerators. His comment is that the scope of the conference was too wide.

In 'Developments in physics' J. V. Dunworth, D. J. Littler and J. Walker consider the use of computing techniques; reactor physics and reactor theory; and research reactors.

Prof. J. Diamond in collaboration with R. H. Burdett, G. W. K. Ford and R. P. Kinsey discuss power reactors in the third lecture which surveys economics; operating experience and the trend of reactor design; and the future of nuclear power and national plans for development.

Lecture number four on 'Developments in reactor technology' by H. Kronberger in collaboration with Prof. W. Murgatroyd and L. M. Wyatt examines fuel elements, heat transfer, and instrumentation.

Metallurgical developments are reviewed by H. M. Finniston in collaboration with L. Grainger in the fifth lecture. The last two lectures are 'Chemical processes' by Prof. J. M. Kay in collaboration with C. G. James, K. Saddington and C. J. Turner; and 'Thermonuclear processes' by D. W. Fry, first presented at Savoy Place on the 4th December 1958 under the title 'A review of work towards nuclear energy from controlled thermonuclear reaction'.

The July 1959 issue contains the papers and discussions relating to the Symposium on Nuclear fuel cycles held by The Institute of Physics in collaboration with the B.N.E.C. on the 22nd and 23rd January 1959. The topics discussed included long-term reactivity changes; once-through fuel cycles; perturbations due to fuel cycles; optimization of fuel cycles; and operational problems associated with fuel cycling.

Also in this issue are the paper by D. Hull and I. L. Mogford on 'The effect of a brittle case on the notched impact transition of unirradiated and irradiated steel' and that by P. Cotterill and H. J. Axon on 'The constitution of bismuth–uranium alloys in the range 0–35 at. % uranium.'

'The use of radioactive isotopes for the investigation of sewage treatment plant' by S. G. Burgess and A. F. Green and 'The design of electro-mechanical auxiliaries directly associated with power-producing reactors' by A. E. Harwood, P. Scott and B. H. Stonehouse are republished.

The *Journal of the B.N.E.C.* is available for sale to the general public, but preferential rates of subscription apply to members of the constituent societies. These societies are: The Institution of Civil Engineers, The Institution of Mechanical Engineers, The Institution of Electrical Engineers, The Institute of Physics, The Institution of Chemical Engineers, The Institute of Metals, The Iron and Steel Institute, The Institute of Fuel, and The Joint Panel on Nuclear Marine Propulsion (comprising The Institute of Marine Engineers, The Institution of Naval Architects, The Institution of Engineers and Shipbuilders in Scotland, and The North-East Coast Institution of Engineers and Shipbuilders).

At a meeting of the B.N.E.C. on Wednesday, 7th October 1959 at 4.45 p.m. sponsored by and held at The Institution of Naval Architects, 10 Upper Belgrave Street, London S.W.1 a paper on 'Nuclear-powered dry cargo ships' will be read by E. C. B. Corlett and E. P. Hawthorne.

For members the annual subscription for the *Journal of the B.N.E.C.* is 30s. post-free (single copies 7s. 6d. each).

More calls on submarine telephone cables

SINCE the transatlantic telephone cable was completed in 1956 traffic—initially greater then expected—has risen steadily. With the object of increasing the capacity of this and other long-distance submarine telephone cables without modifying the cable itself the American Telephone and Telegraph Co. and the British Post Office have developed new terminal equipment. The work in progress either side of the Atlantic was referred to in the November 1958 *Journal* on p. 581.

With the British technique improved channelling apparatus enables telephone circuits to be provided in a bandwidth of 3 kc/s instead of the usual 4 kc/s; while the American method, time-assignment speech interpolation (TASI), utilizes conversation channels idle while speech passes in the opposite direction.

Thus the British system increases the capacity of a cable by a third and the American system doubles it.

THE INSTITUTION EXAMINATION

List of successful candidates

THE ENGINEERING INSTITUTIONS EXAMINATION (PART I) APRIL 1959

THERE are seven institutions participating in the Engineering Institutions Part I Examination:

THE INSTITUTION OF CIVIL ENGINEERS
THE INSTITUTION OF MECHANICAL ENGINEERS
THE INSTITUTION OF ELECTRICAL ENGINEERS
THE INSTITUTION OF MUNICIPAL ENGINEERS
THE INSTITUTE OF MARINE ENGINEERS
THE INSTITUTION OF GAS ENGINEERS
THE NEW ZEALAND INSTITUTION OF ENGINEERS

BRITISH ISLES

The following have satisfied the examiners in the compulsory subjects of Part I (mathematics; applied mechanics; heat, light and sound; principles of electricity; and engineering drawing):

AARONS, Arnold
ABAYAZID, Osman Moukhtar
ALEXANDER, Michael William[2]
ALLISON, Michael[2]
ASLAM, Malik Mohammad Aslam
AUSTEN, Richard John[2]
BADBY, Dennis William[2]
BAILEY, Charles Trevor[2]
BANKS, John Gray
BARBER, Peter Michael[2]
BARR, Michael Robert[2]
BELL, Richard Joseph
BENNETT, Malcolm Cecil[2]
BENNEWITH, John Harry
BLACKBURN, Peter[2]
BLACKER, Peter Robert[2]
BLACKMAN, Thomas Edward George[2]
BOSTON, Arthur Gordon[2]
BROADBENT, Stephen[2]
BURKITT, David Albert[1 2]
BYRNE, Daniel Christopher
BYRNE, John Edward Michael
CARROLL, Gerard Richard
CARSON, William Brian John[2]
CHANDORKAR, Vasant Balkrishna[2]
CHAPPLE, Jonathan Neville
CHARLESWORTH, David Alan
CHITTENDEN, John Michael[2]
CHITTY, Michael Colin[2]
CHOW, Chun Bun
CLEARY, Michael[2]
COGHLAN, John Joseph
COLE, Edward Charles
COLLETT, John Ambrose
COLLINS, David John[2]
CONLON, Antony
COOMBS, Allan James[2]
COOTE, Ian William Thomas
COUSIN, Frank David[2]
COWLEY, Christopher Vincent
CRANE, Anthony Charles
CULLEN, Patrick Francis
DAWBER, Geoffrey Neilsen[2]
DEAN, John Arthur
DELOBELLE, Alain W.
DE SOUZA, Collin Fredrik[2]
DOWELL, Thomas Arthur Richard[2]
DOWNING, Peter[2]
EDMONDS, Derek James
EGAR, Kieran
ELKINS, Neil Albert
EVANS, John Davey[2]
FUSEDALE, Michael John
GAINSFORD, Michael James[2]
GEORGIOU, Nicos Hji
GIBBARD, William Benjamin
GRAHAM, Brian James
GREEN, Barry Newton
GREENHILL, Cecil Arthur[2]
HALLAM, Michael David[2]
HALLAS, John Brook
HAROLD, Leslie John
HASSAN, Abdel-Wahab[1]
HASSAN, Hamid
HAWLING, Philip William
HEBRON, John Donald[2]
HILTON, Edward Brian[2]
HIND, John[2]
HOOPER, John Anthony
HUDSON, Brian Arthur George
HUME, Alan Reginald
JAYAKUMAR, Palainur Balakrishnan
JAYASEELAN, Arasaratnam Elanganayagam[2]
JEWELL, Kenneth George[2]
KESSLER, Albert James
KIRBY, Michael Lewis
KIRKBY, Kevin
KRISHNAN, Narayanaswami
KULATILAKE, Patabendige Sucil Edward de Silva
LIBURD, Charles Augustus[3]
LITTLE, Paul Anthony
LONSDALE, David Arthur[2]
LUNNEY, Bernard[2]
McCARTAY, Timothy Finbarr
McCARTHY, Donal Anthony
McCAUSLAND, Dominick Anthony
McCORMACK, John[2]
MACKIE, Alexander Walter
MACLACHLAN, Norman William
MAGUIRE, Michael Gerard
MAHADEVAN, Chelliah
MALANI, Ratan Hiranand
MALEK, Hooshang
MALEM, Brian Ernest[2]
MALLOCH, David Walter Lawson[2]
MURPHY, Richard Henry
NAGPAL, Sudershan Kumar
NAVARATNAM, Sinnathamby
NOBLE, Patrick Jeremy[2]
O'BRIEN, Kevin Michael
O'CONNOR, Terence Fergus
OLUWOLE, Thomas Akinola Jaiyeola[2]
PATERSON, David Irvine
PELLING, Alan George[2]
PHARANT, Derek Charles[1]
PRASHAR, Satya Pall
QUINE, Gordon Leigh
RAMANATHAN, Thambapillay
RATNANATHER, Joseph Percival Selvam
RENDALL, Dennis Edgar[2]
ROTHERFORTH, Frank Harry
ROWE, Michael Charles
RULE, Hugh[2]
RYMER, David George
SANDERSON, John Reed[2]
SEALE, Robin Andrew
SHANMUGARAJAH, Kanagasabapathy[3]
SHANNON, Fintan Thomas
SHARPE, Roy[2]
SHARPLES, George
SOYANNWO, Sofoluwe Olusola[2]
SRINIVASAN, Mahalinga Sivaraman
STANLEY, Roger Sidney[2]
STANNARD, Royston George William[2]
STEINER, Ralph
STICHBURY, David[2]
TAMPLIN, John Anthony Richard[2]
TAYLOR, Roger Standring[2]
THOMPSON, Ross Delano
THORPE, Laurence Joseph John
TOOMEY, John Joseph
TRIVEDI, Bhupendra
TURZYNSKI, Leon Dominik[2]
UGOCHUKWU, Joseph Chukwuka[2]
VEERASINGAM, Maruthumuthu
VERNON, Brian Colin[2]
WALLACE, Brendan
WALLER, Edwin James[2]
WEST, Peter Edward[2]
WHITTAKER, Arthur
WHITTAKER, John Lindsay
WILLIAMS, David George
WILLIAMS, David Godfrey[2]
WILLIAMS, John Daniel Roberts[2]
WILTSHIRE, Keith Francis
WISHART, James Stanley[2]
YOUNG, John Lindsay[2]
YU, Kin Shiu

[1] *Also satisfied the examiners in the subject of English* [2] *Also satisfied the examiners in the subjects strength of materials and theory of structures* [3] *Also satisfied the examiners in the subject of theory of structures*

The following candidates have satisfied the examiners in the subject of English:

ALLAN, Geoffrey Frank Leslie
ARBON, Maurice
ASHCROFT, Sidney
AYER, John
BACON, David Walter
BAGULEY, John
BEAVAN, James Edward Eric
BENNETT, Peter Graham
BOWERS, Reginald George
BURGESS, John Oliver Hays Norman
BURNELL, Albert William
COOPER, Hugh Bingham
DAVIES, Isaac William Ivor[1]
FALCUS, Mark
FLETCHER, Herbert
FRIESNER, Simeon
GODVERT, Philip Howard
GORDON, John Frederick
GRANT, George
HAIGH, Douglas Patrick Anthony
HARRIS, Ivor Richard
HOWARTH, Harry
HUGGINS, Bernard Frederick
HUGHES, Michael James
JONES, Richard Jeffrey
KELAVKAR, Sharad Kumar
LAKE, John Michael
LEWIS, George Edward
LOGAN, Duncan Stuart
MOORE, William Harvey
MURDOCH, Ian Robert
PAPADOPOULOS, Takis Zacharia
PARROTT, John Noel
PIPER, Hugh David
PRICE, Arthur Douglas
PRINGLE, Malcolm Roderick
REID, Neil George
ROBBINS, William Graham
ROBERTS, Kenneth Howard
SMITH, Peter George
TAHA, Ahmed Abdelrazag Ali
TIMMIS, Edward Albert
WALLACE, Thomas
WELLS, Arthur Dennis
WILLOUGHBY, Roy
WYATT, Norman

[1] *Passed in October 1958*

The following candidates have been permitted to enter the Examination under special conditions and have satisfied the examiners in the subjects indicated:

ABDULLA, Salim[5]
ATHERTON, John Michael Douglas[2 3 4 5]
AUBREY, Eric[2 3 4 5]
BACKHOUSE, David John[1 2 4 5]
BARNETT, Edward Bruce[4]
BEARMAN, Derek Gordon[4]
BEASLEY, Alan Frederick[4]
BERRY, Ronald Charles[2 3 5]
BLOW, Albert Edward[4]
BONE, Harold[4]
BRIDGMAN, Hugh[2 3]
BRIGGS, Peter Frederick[4]
BROWN, Brian Victor[4]
BROWN, Peter William[2 3 5]
BRUNSWICK, Clive[5]
BULL, Roy William[1]
CADMAN, Stanley William Sydney[2 5]
CARPENTER, John[2 5]
CLOUGH, Geoffrey Asquith[4]
CONROY, Ernest William[3]
COOKE, William Montgomery[2]
CORNISH, G. S. C.[3 4 5]
CUNNINGHAM, Wallace[4]
DARLEY, John Christopher[5]
DEAN, John[1]
DICKINSON, George Richard[5]
DODD, Arthur John B.[4]
DORRELL, Christopher James[3 4]
DUCKWORTH, Peter[3 4 5]
FOX, Michael Anthony[1]
FRENCH, Douglas[4]
GEESON, George Ernest[4]
GENTY, Ronald[5]
GREENWOOD, Philip Charles[3 4]
HATFIELD, James[5]
HAYNES, John[5]
HEMPHILL, Robert Walter[1]
HEWITT, Patrick Frederick James[5]
HOGWOOD, Ronald Harry[3]
HORNE, George Herbert[4]
HOUGHTON, Harold Leslie[4]
HUMPHRIES, Malvin John[5]
HUNTER, Alan[4]
HUTCHINSON, Bryan Anthony[1]
JEFFERIES, Harry Victor[5]
JEWKES, Frank[1]
KNIGHT, Bernard Robinson[3]
LAWTON, Bryan[3]
MIDGLEY, James Thomas[1]
MILES, Robert David[4 5]
MORRIS, Duncan Edwin[3]
MOULD, Brian Douglas[3 4]
NEALL, Donald Brian[5]
OKOYE, Christian Ifeatu[2 3 4 5]
PAGE, John Charles[2]
PAGE, Kenneth George James[5]
PALMER, Brian William[3]
PARKINSON, Neil Lambert[3]
POOLE, Barry Stuart[1]
PRINCE, Richard Geoffrey[5]
PUTMAN, Norman John[3 4]
REDKNAP, Brian Vincent[1]
ROBERTS, Ernest Graham[5]
ROBERTS, Kenneth Howard[3]
ROBSON, Colin Anthony[4]
SAMUELSON, Martin[5]
SAVILLE, Terence Dennis Mark[1]
SCHIEFELBEIN, Peter Joachin[3 4 5]
SENNETT, Arthur[3 4]
SHEATH, Rodney[1]
SLACK, Clive Robert[4]
SMITH, Michael John[4]
SMITH, Norman Alan[1]
SPALL, Christopher John[2 5]
STANSFIELD, Peter Robert[1]
SYMES, Max Elliot[2 3 4 5]
VAS, Joseph Alexander[5]
WEIGH, Colin Ferguson[4]
WEST, Derrick[1]
WILLIAMSON, David Ian[4]
WILSON, David[2 3 4]
WILSON, Thomas William[5]
WORRALL, Arthur William[1]
WRIGHT, Brian Crawford[3 4]
WRIGHT, Gordon[2]

[1] *Mathematics* [2] *Applied mechanics* [3] *Heat, light and sound* [4] *Principles of electricity* [5] *Engineering drawing*

OVERSEA

The following have satisfied the examiners in the compulsory subjects of Part I (mathematics; applied mechanics; heat, light and sound; principles of electricity; and engineering drawing):

ABEYNAYAKE, Henry Weerasingha
AGARWAL, Narender Nath
AGHO, Augustine
ANGBA, Ebenezer Kwami
ATHMANI, Roderick
BALAKRISHNAN, Melarcode Hariharan
BALI, Mohan
BHANGU, Joginder Pall
BRAGANZA, Arthur Basil
BUTCHER, Peter John
CHAN CHIANG HENG[2]
CHAN, Chung Kong
CHAN HONG-CHING[2]
CHAN, Lin-Tak
CHANG, Da Wu David
CHOHAN, Jayant Walji
CORREA, Oswald Wilson
DAS, Manik Chandra
DAS, Sriram Chandra
DEP, Leo Kingsley Felix
DE SILVA, Bala Patabendige Senerath Lakdas
DIKSHIT, Subodh Kumar
DOGRA, Om Sarup
D'SA, Edgar Benedict
FERNANDO, Warnaculasuriya Gregory Alfred
GANASON, Ariacutty
GHOSH, Debendra Nath
GNANALINGAM, Sivagurunathar
GONSAL, Dugald Trystan Julius Herbert[2]
GOPAL, Rajagopalan
GUPTA, Harendra Nath
HUANG, Wei Yan
HUI, Sheung Man Laurentius
JACOB, Mazuanchary Abraham
JAIN, Raj Kumar
JAIN, Rajinder Kumar
JAIN, Satendra Lal
JAYAWARDENE, Hapuarachchige Munidasa
KAR, Asit Ranjan[2]
KARUNARATNE, Karunamuni Bernard Eric de Silva[2]
KHARE, Gyanendra Kumar
KIANG, Sheng Wei William
KOH BOON CHOR[2]
KOON YEW YIN[2]
KORIA, Jivraj Karsan
KUMAR, Dalip
KUMAR, Ram
KWAN, Lei Tuen
KWOK, Pui-Sang
LAL, Hridaya Narain
LEE, Jee Luan
LEUNG, Yui-Cheong
LIM BOON KANG[2]
LIM, See Yin
LOKANATHAN, Srinivasanallur Gopalakrishna
LOOMBA, Govind Sharan
LOTAY, Pyara Singh
MA, Che Keung
MALHOTRA, Gopal Krishna
MALIK, Prem Kumar
MANICKAVASAGAR, Selliah
MASIHUZZAMAN
MATHUR, Krishan Kumar
MATHUR, Surendra Narain
MENDIS, Warnakulasuriya W. J.
MIMANO, Julius
MITHA, Sadruddin Hasham
MITHAL, Anirudh
NAGULESWARAN, Sivapatham
NANGIA, Shashi Kumar
NARAYANAN, Vedantham
NORONHA, Frederick Caetano Filipe
OMIGIE, Felix Nerhunwa
OWUSU, Isaac Kwabena
PANESAR, Surjit Singh
PATEL, Kumud Chandra
PATEL, Rajnikant
PAUL, Madhusudhan
PRELIS, Moksevi Rasingh
RADHAKRISHNA RAO, G. K.
RAJANISH, Vichitra
RENGANATHAN, Nadarajah
SABARATNAM, Pasupathy
SACHDEVA, Amrit Lall
SAMANI, Amritlal Gokaldas
SAPRE, Laxman Purshottam
SARANGDHAR, Ramant Anant[1]
SARSHAR, Muhammad Iqbal
SEMBUKUTTIARTCHI, Don Christopher
SEN GUPTA, Manindra Nath
SHAH, Pravin Devchand
SINGH, Hemant
SINHA, Anand Shanker Prasad
SIVATHASAN, Thambiah
SOMAIYA, Shashikant Hemraj
SRINATH, Nandyal
SRIPATHY, Kathrippillay
SUBRAMANIAN, Sarma
SUNDARAM, Anantal Ram[2]
SUPIRAMANIAN, Kandiah Murugesu[2]
THAKUR, Jagannath
THANGIAH, Jebaraj Barnabas Adulfus
THIAGARAJAH, Subramaniam[1]
VENKARARAMAN, Seetharaman
WIJETILLEKE, Kariyawasam Katukolihe Gamage Lakdasa[2]
WONG, Nai Fung
YAP LIM SEN[2]
YOGANATHAN, Kandiah
YOGANAYAGAM, Nagaratnam
YUEN, Siu Sing

[1] *Also satisfied the examiners in the subject of English* [2] *Also satisfied the examiners in the subjects strength of materials and theory of structures*

The following candidates have satisfied the examiners in the subject of English:

ABAYASEKARA, Joseph Danzil
ALDRIDGE, David William
ALVI, Shamin Mahmood Basharat
BEDFORD, Geoffrey
BHATHENA, Jamshed
BRIGHT, Anthony George Reginald
BROOKS, Adrian John
CONNELLY, Alexander
COWARD, Ronald Norman
DAMRELL, Brian
EBOFIN, Folorunso Olalekan
GOODWIN, John James
JENKINS, William Eric
JOHNSON, Brian John
JOSHI, Manshanker G.
LEE, David
McGILVERY, William
MATTHEWS, William Donald
MEARA, Michael John
MOUNTSTEVENS, Ivan Vaughan
MURTHY, Pemmaraju Seetharama
PANCHOLI, Harshad
PARTHASARATHY, Rajagopalan
PAYNE, John Henry
PEIRIS, Hanwedige Aryasena
PILLAI, Nagaratnam Kumararajavelu
POLLOCK, Anthony Andrew
ROY, Bijon Behari
SEETHARAMAN, V. Iyer
SINGH, Kartar
WARE, Leslie William Thomas
WILKHU, Inder Paul

The following candidates have been permitted to enter the Examination under special conditions and have satisfied the examiners in the subjects indicated:

ADAMS, Vistrini Bede[5]
ASHA, John Bryan[3]
BASU, Tarun Kumar[2 3]
BLAMIRE, John[4]
BOYD, John[3 4]
BREW, James Richard[2 3 4 5]
BUCKINGHAM, Douglas Ramage[4]
BURRA, Narasimh Murty[2]
CHEUNG, Kam Wing[1 3 4]
DESAI, Sharadchandra Markandrao[5]
FREDERICK, Michael Campbell[4]
GARFITT, Leslie[3 4]
HANIF, Mohd[1 5]
HEAD, Adrian Falkner[1]
HERATH, Kolitha[2 3 4 5]
HUSSAIN, Mohammed Mosharraf[4]
IBBERSON, Malcolm[3]
JAIN, Tara Chand[5]
KHENG YEANG TAN[1]
KHURANA, Chaten Parkash[5]
KRISHNAMURTHY, Selvaratnam[3 4 5]
LO KWOK KUEN[3 4 5]
MACKAY, Malcolm Hedley[5]
MANGAPATIRAO, Avasarala[5]
MEHROTRA, Vinod Kumar[5]
MILLMAN, James Alan[4]
PADAN, Gurbax Singh[3 4]

[1] *Mathematics* [2] *Applied mechanics* [3] *Heat, light and sound* [4] *Principles of electricity* [5] *Engineering drawing*

The Institution Examination: List of successful candidates (continued)

PERERA, Gabadagamage Dharmapriya Amarasiri[2 3 4 5]
RAJANAYAGAM, Ilanganayagam[3 4 5]
ROWCROFT, Alan Roy[3]
SCHOFIELD, Norman[3 4]
SHARMA, Grish Kumar[5]
SHARMA, Om Parkash[5]
SHAW, Jeffrey[4]
SONI, Triloki Nath[3]
STOW, Robin James William Crossley[2 4 5]
SURIYA DEVA, Subramaniam[3 4 5]
WICHRAMASINGHA, Ranjit Lakshamana[3 4 5]
WIJEWARDENA, Dehiwala Liyanage Don Kulap ala[2 3 4 5]

[1] *Mathematics* [2] *Applied mechanics* [3] *Heat, light and sound* [4] *Principles of electricity* [5] *Engineering drawing*

THE INSTITUTION EXAMINATION (PART II) APRIL 1959

BRITISH ISLES

ACHARYYA, Susil Chandra
ADBY, George Colin[3]
ADDISON, Terence Michael[4]
BEANEY, Michael Edward[3]
BEESON, Douglas Paul[3]
BENNETT, Roger Stephen[1]
BULL, Donald Malcolm[1]
CHATWIN, John Arthur[2]
CHILVER, Brian[1]
CLYDE, Ronald Buchanan
COLLINSON, Christopher David[1]
CUNNINGHAM, Anthony John[3]
DAVIS, Peter[4]
DAWES, Alan James[3]
DAY, Harold Michael Chapman[5]
DENNE, Phillip Raymond Michael[1]
FYFE, Robert Lendrum[1]
GLEESON, Peter Thomas[1]
GOPINATH, Anand
HANDFORD, Michael Phillip[3]
HYDE, David Blake[3]
IVES, Charles Victor[4]
LAMB, Bryan Charles Gilbert[4]
LENNON, Leo[3]
LEWIS, Robert Tony[1]
McCALL, Maurice
MASTERMAN, John Michael[1]
MOAT, Alistair Cooper[4]
MORRIS, Clive[1]
MORRIS, Frank[4]
NEWTON, Robert Dorrick[3]
NORRIS, Paul Mitchell
OZORO, Okwuesa[1]
PASKINS, Michael[5]
PEABODY, Christopher John[3]
PITTS, Ronald Stephen
POOL, William John[5]
POWNER, Edwin Thomas[3]
PRINGLE, James Alexander Sharpe[3]
PULANTHIRAN, Eliathamby
RACKHAM, David John[3]
RASHID, Abdul
RAWLINGS, Terence Dowse[3]
RICHARDSON, Julian[4]
RODGERS, David Alexander[3]
SINCLAIR, Peter Oliver[3]
SMITH, Philip John Mytton[4]
SPARKS, Gordon Leslie[3]
STEELE, Derek Herbert[3]
SUTTON, Norman Ronald[3]
TAMBE, Pratap Shripad
THOMPSON, Raymond[3]
THURBIN, Patrick John[3]
TUCK, Kenneth Richard[1]
WATT, Alan Vallack
WHITE, Raymond Anthony[3]
WHITEHOUSE, Joseph Colin[1]
WHITELEY, Michael Christopher[1]
WILKINS, Peter Granville[1]
WOLFE, Derek Arthur[3]
WOOD, Anthony Richard[1]
WOOD, David John[3]

OVERSEA

CHAN, Joseph Kim Tsau Hung
CHANDAK, Bhawani Shankar
FREEMAN, Joseph Brian Alexander
GNANASABESAN, Subramaniam
JEGARAJAH, Chellappu Francis
PERERA, Hilary Everad[1]
SANDIRASEGARAM, Joseph
SANDRASEGARAM, Sampanther[1]
SHAH, Hasmukhlal Purshottamdas
THAYANANDARAJAH, Somasundram

[1] *Electrical engineering I and II* [2] *Electrical engineering II* [3] *Engineering physics* [4] *Thermodynamics* [5] *Mathematics*

THE INSTITUTION EXAMINATION (PART III) JUNE 1959

BRITISH ISLES

ABBOTT, Percy William[1]
ADBY, George Colin
ADDISON, Terence Michael[1 5]
ALLSOP, Gerald Anthony[1 6]
AMOR, Dennis Craig[1]
ANDERSON, Dennis
ASHDOWN, Denis Edward[1]
ASHE, David Arnold[1]
AULT, Maurice Peter
AYRE, John Kenneth
BACON, David James Bernard[1 2]
BANCROFT, George[5]
BARKER, Maurice
BARNETT, Christopher Frank[1 3]
BARVE, Sharad Purushottam[3]
BEARD, Robert Victor
BEAUMONT, Jack[6]
BIRD, Kenneth Henry George[1]
BLACKWOOD, William
BONNICK, Bryan John[1]
BOWTHORPE, John Willis
BOYCE, Kenneth Ronald[1 4]
BRENNAN, Francis Michael[1 3]
BROWN, Peter Kenneth[5]
BRYDEN, Eric[3 5]
BRYSON-HAYNES, Donald
BUCKLAND, Christopher John[1]
BURDEN, Barry Thurlow
CARTER, Alexander[1]
CAVANAGH, Eric Joseph[1 5]
CHADWICK, Geoffrey Alan[5]
CHALLIS, Michael Jeremy[1]
CHAMBERS, Jack[6]
CHANDLER, Kenneth[1]
CHARD, Walter Keith
CHEESEMAN, Roy Lawrence[5]
CHETWYND, David Stuart
CLARK, John Charles[1]
CLARKE, Roy Wellesley[1]
COLLING, John Anthony[7 8]
COLLINSON, Christopher David
COOK, Graham Arthur[5]
COOPER, Brian Frederick[1]
CORREIA, John Basil[4]
COUSINS, John Philip
COWLING, Peter[6]
CRANSHAW, Arthur James[1 4]
CROWTHER, Peter John[2]
CRYER, Derek Frank[4 6]
CUTHBERTSON, Robert William[6]
DANDO, Graham[5]
DARBYSHIRE, Leslie[1 5]
DAVIS, Peter[2]
DAWES, Alan James
DAWSON, Michael John Groombridge[1]
DEAKIN, Barry[1]
DEMPSEY, Thomas Anthony[5]
DEVINE, Trevor James
DICKSON, John Graeme[1]
DIXON, Neil[1]
DIXON, Ronald
DUCK, George William[1]
DWYER, Alfred[1]
DYER, Edward James
DYMOTT, Peter Harry[5]
ELTAYEB, Eltayeb Ahmed[1]
EVANS, Byron John[1]
EVANS, Ronald Herbert James Pugh[1 5]
FERRETT, Neil Antony[5]
FIELDING, Allan[1]
FITZPATRICK, Christopher Martin[5]
FORSTER, John[1]
FOXFORD, John Victor[1 3]
FRANKLIN, Graham John
FREENEY, John Brendan[5]
FROW, Roger[1]
FYFE, Robert Lendrum[1]
GARDNER, Michael George[1]
GERRETT, Derek Charles[1 4]
GIBSON, David Charles[2]
GOODENOUGH, Paul Douglas
GOULD, Reginald Dennis
GRACE, Michael John[1]
GREEN, Michael Donald[1]
GREW, Richard John McIlroy[1]
GRIZZELL, Richard Laurence[4 6]
GROOM, Norman George[1 5]
HABENS, Bernard[1 5]
HALL, Brian[1 4]
HALLAM, Trevor James
HALLIWELL, David Anthony[1]
HARDING, Robert Harold[1]
HASTINGS, William[1]
HELLIWELL, Alan James[1 5]
HOCKENHULL, Nicholas Charles Headington[6]
HOLLIS, Frank Charles[2 6]
HOMER, Robert James[1]
HOOK, George William
HORSFIELD, Michael[1]
HUCKLE, Derek[1 4]
HULL, Peter Reynold[1 6]
HUMPHREYS, Dennis Arthur[1]
HUNTLEY, Michael William Elliott[4 6]
HUTCHERSON, Peter[1]
IBRAHIM, Badreldin[1]
IRVING, Philip Byron[1 6]
IVES, Charles Victor
IVESON, Albert John[1 4]
JAQUES, James Brian[1]
JASKOLSKI, Andrzej Stefan[3 5]
JEFFERY, Alan[5]
JOHNSON, Philip Ian[3]
KHOKHAR, Abdur Rashid[6]
KNOWLES, Joseph[1 4]
KNUTTON, Harry[1]
KWOK, Ping-Ki
LAKE, Malcolm Winfield[6]
LAMB, Bryan Charles Gilbert[2]
LANE, Robert Marshall[5]
LEGG, Malcolm[1]
LENNON, Leo
LEWIS, Harold Windsor[1]
LITTLE, James Joseph
LLOYD, Denis George[1]
LOFT, Graham Arthur[1]
LYONS, Clifford Henry[7]
MAAS, Michael Jan[1]
MACDONALD, Malcolm Hugh[1]
MACKIE, James Findlay
MANN, Ernest George[1]
MANTON, Colin Brian[1]
MARLOW, John Albert
MARSHALL, John Edward[1]
MARTLEW, Allan[1]
MEWES, Kenneth George Matthew
MICHELL, Michael Graham
MILES, Donald Victor[1]
MILLS, Michael Rudolph[1]
MILLWARD, John David[1]
MILNE, John Gilbert[1]
MILTON, Robert Leonard[1]
MITCHELL, Terence[5]
MOAT, Alistair Cooper[2 6]
MONTEIRO, Alfred Peter[1]
MOORE, Bryan[1]
MORAGHAN, James Sylvester[5]
MORRIS, Frank[5]
MORRIS, George Edwin[5]
MOSES, George Edward[4 6]
NEWMAN, Allan Frederick[1 5]
NEWMARCH, Derek Charles[1 5]
NIELSON, Adrian William[6]
NIGHTINGALE, Clive Richard[1]
NORRIE, William Malcolm[1]
OPONG, Nathan[5]
OULTRAM, William George[1]
OVERY, Edward David[1 5]
PAGEDAR, Arvind Kamalakar[2]
PATTEN, Arthur Robert Adrian
PELLY, Brian Raymond

[1] *Advanced electrical engineering* [2] *Electrical machines* [3] *Electrical measurement* [4] *Electrical supply* [5] *Electronic engineering* [6] *Utilization of electrical plant* [7] *Line communication* [8] *Radiocommunication*

PIERCE, Reginald Roy[1 5]
PILBIN, Brian
PILLAY, Ratnam Kandaswamy[3]
POWNER, Edwin Thomas[1]
PRICE, Nicholas Nadine Aitken[1]
PRINGLE, James Alexander Sharpe
RACKHAM, David John
RANADE, Suresh Parashuram
REICHER, George John[1]
RICHARDSON, Colin Albert Stanley[1]
RICHARDSON, Julian
RINTOUL, John Howard[1 4]
RODGERS, David Alexander[1 3]
ROGERS, Bryan Charles[1 5]
ROTHWELL, Ronald
ROWNTREE, James[1]
SAGAR, Peter Alan[5]
SHARPE, Terence Clifford
SHAW, Robert William[1]
SHEPHERD, John Teesdale[1 5]
SHOREMAN, Derek[1]
SHOTTON, John
SINCLAIR, Peter Oliver[1]
SLACK, Alan[1]
SMITH, Albert Alan
SMITH, Brian Frederick[1]
SMITH, Philip John Mytton[6]
STABLES, Alistair Mitchell[6]
STEELE, Derek Herbert[1]
STERRY, John William[1]
STICKLAND, William John
STOCKLEY, Robert Ezra James
SUNTHARALINGAM, Nagalingam[1 5]
SUTTON, Norman Ronald[1]
TEO, Chye Poh[5 8]
THEAKSTON, James Michael[6]
THICKPENNY, John[5 6]
THOMAS, David John[1 5]
THOMAS, Keith[1]
THOMPSON, John Dennis Vernon[1]
THOMPSON, Raymond
THORNCROFT, Roy Charles[1 5]
TIBBENHAM, William Percy[1 3]
TINGEY, Terence Patrick[5]
TODD, Robert John[1]
TOMASINA, Ronald John Peter[1]
TOWERS, Alan[1]
TSANG, Hin-Wa Albert[1]
TUCK, David William[1]
TYSON, Edwin[3 4]
UBOSI, Bertram Ogugua Chukwudozie[2]
UNDERWOOD, Justin Dowsett[5]
WAKEFIELD, John Robert[1 6]
WALDRON, Thomas William[1 8]
WALSH, Steven Roger[5 8]
WARD, William Bulmer[4]
WATKINS, Brian John[1 4]
WATSON, John Bethall[2 6]
WEBB, Leonard Victor[1]
WESTON, Anthony Ashby[6]
WHARAM, Robert Geoffrey
WHITAKER, George David[1]
WHITE, Alan Graham[1 5]
WHITFIELD, Neville Stuart[2]
WILKINSON, Brian[1]
WILLDEY, Geoffrey Michael[5]
WILLIAMSON, Rupert Keith[5]
WILMAN, Hugh[5]
WILSON, Robert Alan[1]
WISHART, Keith[1 4]
WOOLLEY, Frederick Edward[1]
WRIGHT, William[5]
YIP, Shui Cheong[1]
YOUNG, Brian Guy[1]
YOUNG, Peter Grafton Craig[1]

OVERSEA

ARIYANANDA, Kamburugamuwe Lokuruge[1 4]
ARUMUGAM, Kandiah[1]
FIELD, Denis Michael[1]
GOONASEKERA, Lakshman Kirthisri[1]
GUNASEKERA, George Oscar Samarasinghe[1]
GUPTA, Ajoy Kumar[1 5]
HEPPONSTALL, Bertram Rex
HOOGHAN, Naramolaksingh Ramsingh
JAYAWICKRAMA, Priya Padma[1 5]
JAYENDRAN, Ariacutty[1 3]
JESUTHASAN, Moses Daniel[1]
KURUPPU, Upali Srimath
MADAN, Om Prakash[1 2]
MARATHEY, Jayant Purandara[5]
MEHTA, Ramchandra Nathalal[1]
NAGARAJAH, Ramappillai
OAK, Govind Gangadhar
PARKASH, Som
PICHAI, Venugopal
RADHAKRISHNAN, Thangavelu[2]
RAJAGOPALARAO, Patnayakuni[1]
RAMCHANDRAN, Karumanassery Parasuram[1 2]
ROZENSTEIN, Solomon[1]
SANDIRASEGARAM, Joseph[1]
SRIHARAN, Sivasambo
SUNDARAM, Kanapathippillai Thirugnana[1]
THAPAR, Baldev
VELAUTHAPILLAI, Thampu[1 4]
VELSAMY, Appathurai[3 4]
WIJETUNGA, Lebunuhewage Harischandra Rohana[1 3]
ZUBAIR, Mohamed

[1] *Advanced electrical engineering* [2] *Electrical machines* [3] *Electrical measurement* [4] *Electricity supply* [5] *Electronic engineering* [6] *Utilization of electrical plant* [7] *Line communication* [8] *Radiocommunication*

New television stations

THE B.B.C.'s new service for East Anglia will begin regular programmes on the 5th October 1959 when the television and v.h.f. sound broadcasting station at Morborne Hill near Peterborough, Northamptonshire, comes into operation. This will provide television programmes for an additional 150000 people, improving reception for many more. Within range will be Long Sutton, Bourne and Spalding (Lincs.), Oakham (Rutland), Kettering (Northants.), St. Neots (Hunts.), Biggleswade (Beds.), Ely (Cambs.) and Downham Market (Norfolk). The v.h.f. transmission of the three B.B.C. sound programmes will serve Cambridge and Bedford in addition.

A new television studio in Norwich will enable East Anglian material to be included in B.B.C. television programmes both local and national. The studio will be linked with the B.B.C.'s television station at Tacolneston near Norwich by a B.B.C. radio link.

Television will be transmitted in Channel 5 (vision frequency 66·75 Mc/s, sound 63·25 Mc/s) using horizontal polarization, with an effective radiated power of 1 kW in all directions.

Commercial television will be brought to East Anglia on the 27th October 1959 when the new station of the Independent Television Authority at Mendlesham near Stowmarket, Suffolk, begins transmissions. Another new station of the Authority at Black Mountain near Belfast will provide commercial television for Northern Ireland from the 31st October 1959. More than a million people will be within its service area there which means that less than 9% of the population of the United Kingdom will be outside one or other of the areas covered by the Authority. The Black Mountain station will operate on Channel 9 and transmit horizontally polarized signals.

Forthcoming events

ALL meetings are held at Savoy Place beginning at 5.30 p.m. (tea at 5 p.m.) except where otherwise stated. The nature of the meeting is indicated by the following key:

ED EDUCATION DISCUSSION CIRCLE
E ELECTRONICS AND COMMUNICATIONS SECTION
I INFORMAL
M MEASUREMENT AND CONTROL SECTION
O ORDINARY
S SUPPLY SECTION
U UTILIZATION SECTION

After each paper that has already been published is added the month when a synopsis appeared in the *Journal* under 'Papers and monographs published individually this month', i.e. about the time when the paper was published as a separate. A paper that has not yet been published will be available at least ten days before the meeting at which it will be read. The full list of London meetings is given in the meetings card

October 1959

O **9** *Friday* SIR WILLIS JACKSON, D.SC., D.PHIL., DR.SC.TECH., F.R.S. Inaugural Address as President‡ (see p. 554 for note on place of meeting)

I **12** *Monday* The President will open a discussion on 'Is the present pace of electrical progress good for the community?'*

M **13** *Tuesday* PROF. A. TUSTIN, M.SC. Chairman's Address 'Relationship of physical mechanisms to psychological processes'‡

ED **14** *Wednesday* W. H. TAYLOR, B.SC.(ENG.), will open a discussion on 'Graduate training in industry'* (at 6 p.m., tea at 5.30 p.m.)

U **15** *Thursday* T. E. HOUGHTON, M.ENG. Chairman's Address 'The electrical engineer and the heavy chemical industry'‡

S **21** *Wednesday* J. R. MORTLOCK, PH.D., B.SC.(ENG.). Chairman's Address 'Where next?'‡

M **27** *Tuesday* W. RENWICK, M.A., B.SC., will open a discussion on 'Future trends in memory stores for high-speed digital computers'†

E **28** *Wednesday* M. J. L. PULLING, C.B.E., M.A. Chairman's Address 'Development of Eurovision'‡

* No advance information will be available, and no Press report will be permitted
† An abstract will be available in advance
‡ No advance information will be available

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 19TH AUGUST 1959

	No. of contributors	£	*s.*	*d.*
£1000 and over	8	8685	0	0
£100 to <£1000	32	7181	3	0
£5 to <£100	894	9379	2	9
£2 to <£5	2179	6019	2	7
under £2	26437	13868	7	0
		£45132	15	4

APPOINTMENTS AND NOMINATIONS

OVERSEA REPRESENTATIVE

THE Council have appointed Prof. J. A. Harle M.SC., MEMBER, their Oversea Representative for Alberta, Canada.

I.E.E./I.MECH.E. JOINT COMMITTEE ON MODEL FORMS OF GENERAL CONDITIONS OF CONTRACT
COMMITTEE ON MODEL FORMS OF GENERAL CONDITIONS OF CONTRACT (ELECTRICAL)

On the nomination of the B.E.A.M.A. the two Councils have appointed Mr. F. J. B. Barry to serve on the above two committees in place of Mr. T. H. Kelsey, M.A., MEMBER.

I.E.E./I.MECH.E. JOINT COMMITTEE ON MODEL FORMS OF GENERAL CONDITIONS OF CONTRACT

On the nomination of the Electricity Council the two Councils have appointed Mr. L. H. Welch, O.B.E., B.SC.(ENG.), MEMBER, Mr. H. B. Morton, Mr. F. S. Naylor, B.SC.(ENG.), MEMBER, and Mr. L. F. Miller to serve on the above committee following a review of the representation of the supply industry.

COMMITTEE ON REGULATIONS FOR THE ELECTRICAL EQUIPMENT OF AIRCRAFT

On the nomination of the Cable Makers Association the Council have appointed Mr. D. W. Bird, B.SC., to succeed Mr. E. Tunnicliff, M.SC., ASSOCIATE MEMBER, on the above committee.

MINISTRY OF LABOUR AND NATIONAL SERVICE—ENGINEERING ADVISORY PANEL

The Council have nominated Mr. T. E. Goldup, C.B.E., PAST-PRESIDENT, Mr. B. L. Metcalf, B.SC.(ENG.), MEMBER, and Mr. W. K. Brasher, C.B.E., M.A., SECRETARY, as their representatives on the above new panel.

WOMEN'S ENGINEERING SOCIETY—COUNCIL

The Council have nominated Sir Willis Jackson, D.SC., D.PHIL., DR.SC.TECH., F.R.S., PRESIDENT-ELECT, as their representative on the above council in place of Sir Arthur Fleming. C.B.E., D.ENG., LL.D., PAST-PRESIDENT, who has resigned.

B.S.I. TECHNICAL COMMITTEE ELE/85—ELECTRICAL PROTECTIVE SYSTEMS

The Council have nominated Mr. G. W. B. Mitchell, B.A., MEMBER, as their representative on the above new committee.

PROPOSED JOINT BRITISH COMMITTEE FOR VACUUM SCIENCE AND TECHNOLOGY

On the invitation of the Institute of Physics the Council have nominated Prof. M. R. Gavin, M.B.E., M.A., D.SC., MEMBER, and Mr. J. Blears, B.SC.(ENG.), ASSOCIATE MEMBER, as their representatives on the above proposed committee.

ARRANGEMENTS FOR THE OPENING MEETING OF THE 1959–60 SESSION

PRESIDENT'S INAUGURAL ADDRESS

IT was announced in Forthcoming events on p. 477 of the August issue of the *Journal* that the Inaugural Address as President by Sir Willis Jackson, D.SC., D.PHIL., DR.SC.TECH., F.R.S., would take place on Thursday, 8th October 1959. In view however of the selection of this date for the General Election it has been decided to hold the Opening Meeting on **Friday, 9th October 1959.**

As this issue of the *Journal* goes to press it is still expected that, despite certain problems and difficulties which have arisen in the course of altering an existing structure, the first stage of the rebuilding of the Lecture Theatre will be completed in time for the Opening Meeting to be held in that room. In the event however of it proving necessary to hold the meeting elsewhere, members in the London area will be notified by post beforehand and an announcement will also be made in the technical Press.

PROGRAMME OF MEETINGS

SESSION 1959–60

THE programme card of London meetings for the first half of the session is being sent with this issue of the *Journal* to all members not residing within the area of a local Centre or Sub-Centre.

Any member living in the Provinces who often visits London and is thus able to attend London meetings may obtain a copy of the London card on application to the Secretary.

CHANGE OF DATE

MEMBERS are asked to note that the Ordinary Meeting at which Mr. C. B. B. Wood and Mr. I. J. Shelley are to deliver a lecture on 'The transmission of news film over the trans-atlantic cable' will take place on **Thursday, 3rd December 1959** and not as previously announced on the 22nd October 1959.

FUTURE CONFERENCES

PLANS FOR 1960 AND 1961

THE Third international conference on Medical electronics will take place in the second half of July 1960, and in September 1961 there will be a Convention on the Impact of nuclear development on electricity supply and on instrument techniques.

Both events will be in London and are being organized with the support of the Council, the first by the Electronics and Communications Section in association with the International Federation for Medical Electronics which was inaugurated in 1959, and the second by the Measurement and Control and Supply Sections jointly. The keynote of the Medical electronics conference is the bringing together of the medical and electrical engineering professions for mutual discussion and better understanding of respective problems. General sessions will enable medical practitioners and electrical engineers who are not experts in medical electronics to increase their background knowledge of the subject. At specialist sessions those engaged in work on medical electronics will present papers on the latest developments and discuss specific topics in technical detail. It is planned to hold an international scientific exhibition on medical electronics in connection with the conference.

At the Nuclear development convention members will examine present and future energy requirements in relation to available energy resources; economics; operating characteristics; the siting of nuclear power stations and its effect on system planning; health physics; radiation detectors; pulse circuits; nuclear measuring instruments for research and process control and for prospecting and mining applications; instruments for nuclear reactors and associated plants; and data-processing for nuclear applications. It is expected that technical visits will be arranged. The organizing committee invite papers for consideration. It is understood that the Federation of British Industries are considering holding a conference on the general problems of nuclear generation during 1961, and where possible there will be an appropriate co-ordination of events.

DELAY IN PUBLICATION OF THE PROCEEDINGS

IT is regretted that owing to the recent dispute in the printing industry certain issues of the *Proceedings* have lost synchronism with their months. Thus July Part B appeared at the end of August, August Part A is being published this month, and September Part B will appear in October. September Part C, consisting of Monographs which have already been published individually, and October Part A are not affected.

LIST OF MEMBERS, PART I, 1959

IT is regretted that owing to the recent printing dispute there will be some unavoidable delay in the publication of the above list. Members who have ordered copies are therefore asked to note that they are likely to receive them in early January 1960 instead of during November 1959 as previously arranged.

RELIABILITY OF DIGITAL COMPUTERS

A SERIES of discussion meetings will be held at Savoy Place on Wednesday and Thursday, 20th–21st January 1960 on 'Managerial and engineering aspects of reliability and maintenance of digital-computer systems'.

The programme will be divided, and on the first day the British Computer Society will be responsible for arranging meetings which will deal with methods of determining the functioning status of a system, recording techniques for determining operating efficiency of a system, programming techniques for protection against transient failures, and management and organization problems.

On the second day the discussions will be concerned with such topics as experience of system reliability, the influence of engineering design on reliability and factors affecting the reliability of peripheral equipment. These meetings will be organized by the Measurement and Control Section with the support of the Council. Anyone wishing to contribute material is asked to submit a digest of about 500 words, for a 10–15 minute contribution, to the Secretary of The Institution by the 30th October 1959.

The whole series is being held under the aegis of Group B, the British Group for Computation and Automatic Control of the British Conference on Automation and Computation.

MEMBERS' GUESTS

MEMBERS are reminded that under the Bye-laws of The Institution every member (Students excepted) is entitled to introduce one visitor at each Ordinary Meeting. By direction of the Council this also applies to all meetings of the Electronics and Communications, Measurement and Control, Supply, and Utilization Sections and to Informal Meetings.

DISCUSSIONS AT MEETINGS

THE Council desire it to be understood that contributions to the discussion at meetings should not be read from manuscript since they consider that this form of presentation is contrary to the true spirit of a discussion.

WRITTEN CONTRIBUTIONS TO DISCUSSIONS

MEMBERS who are unable to be present at a meeting or who if present do not have an opportunity of speaking may submit written contributions to the discussion which will be considered for publication in the *Proceedings*.

We would also remind members that written contributions on papers published in the *Proceedings* without being read at meetings will be considered for publication.

COMMUNICATIONS FROM OVERSEA MEMBERS

OVERSEA members are specially invited to submit for publication in the *Proceedings* written communications on papers read before The Institution or published in the *Proceedings* without being read. The contributor's country of residence will be indicated. Brief articles, items of news and photographs intended for the *Journal* will also be most welcome.

Copies of all papers which will be read before The Institution are sent to each Oversea Representative of the Council for distribution to members likely to be in a position to submit communications.

SUBSCRIPTIONS AND INCOME-TAX RELIEF

WE are informed by the Inland Revenue that those members whose annual membership subscriptions qualify for relief under Section 16 of the Finance Act 1958 and who pay an additional annual subscription to receive the *Proceedings* may be relieved under this Section in respect of this additional subscription also: that is, this subscription will be allowable as a deduction from the amount of the emoluments of such a member assessable to income tax under Schedule E.

Members concerned are referred to their local Inspectors of Taxes.

AUTOMATIC CONTROLS IN THE U.S.S.R.

COPIES of the report of the British team of experts in automatic control who visited the Soviet Union in May 1959 to study the development and applications of automatic control techniques in industry (see p. 521) will shortly be available and may be obtained on application to the Honorary Secretary, Group B, British Conference on Automation and Computation, c/o The Institution of Electrical Engineers, Savoy Place, London W.C.2.

TRAFFIC ENGINEERING

A TRAFFIC Engineering Study Group has been established by The Institution of Civil Engineers. The objects of the group are (1) to promote the general advancement of the science of traffic engineering, (2) to foster papers or other communications, (3) to arrange visits, and (4) to provide a forum for the discussion of problems in the subject.

The chairman of the committee set up by The Institution of Civil Engineers to be responsible for the organization of the activities of the group is R. M. Wynne-Edwards, D.S.O., O.B.E., M.C., M.A. Monthly informal meetings are being arranged for the 1959–60 Session when it is hoped to discuss urban intersections, design of rural roads, traffic engineering in London, junction design on motorways, and parking. The meetings will be held at 1–7 Great George Street, Westminster, London S.W.1 on Thursdays at 5.30 p.m. (tea at 5 p.m.).

The Institution of Civil Engineers would be very pleased to receive applications for membership of the group from members of our Institution who are professionally interested in traffic engineering. Application forms may be obtained from the Secretary. For the time being no subscription will be payable for membership of the group.

WORLD POWER CONFERENCE

A SECTIONAL meeting of the World Power Conference will be held in Madrid from the 5th to 9th June 1960 on the theme Methods for solving power-shortage problems. The British National Committee will present 17 or 18 papers at this meeting. Eight of these will be of direct electrical engineering interest and will deal with forecasting electricity requirements; energy resources and growth of consumption in Scotland; development of large electricity generating units; economics of nuclear power in Great Britain; training operating staff for the first British nuclear power stations; technical and economical development of the gas-cooled reactor; factors influencing development of a nuclear power programme; and integrating nuclear power into a large electricity generating system.

The general programme, with membership and other application forms and particulars of six post-conference tours, will be published by the Spanish National Committee at the end of November 1959. In the meantime notification of intention to participate should be sent to the Secretary, British National Committee, World Power Conference, 201–2 Grand Buildings, Trafalgar Square, London W.C.2.

At a meeting of the International Executive Council in Rome on the 12th–13th June 1959 Argentina was readmitted to membership of the Conference. These countries were elected members: Cuba, Ghana, Morocco, and Nigeria, making a total of 59. The theme of the 6th (Plenary) World Power Conference in Melbourne in October 1962 will be the changing pattern of power.

LECTURES ON LIGHT

THE Illuminating Engineering Society has arranged a series of lectures for October 1959 as part of its Golden Jubilee celebrations.

The first lecture on Thursday, 15th October will deal with 'The nature of light' and be given by Sir Lawrence Bragg, F.R.S., at the Royal Institution, Albemarle Street, London W.1 under the chairmanship of Lord Brabazon of Tara. Mr. L. J. Davies will deliver the second lecture on 'The generation of light' on Tuesday, 20th October at Savoy Place under the chairmanship of Sir Harold Hartley, F.R.S. 'Light and road safety' is the title of the third lecture, to be read by Dr. W. H. Glanville, F.R.S., at the Institution of Civil Engineers, Great George Street, London S.W.1 on Thursday, 22nd October when Mr. R. Gresham Cooke, M.P., will be chairman. On Tuesday, 27th October Mr. A. N. Irens will present the final lecture on the subject of 'Light and productivity' at the Federation of British Industries, Tothill Street, London S.W.1 with Mr. Peter Masefield in the chair.

Admission will be by ticket only, obtainable on application to the Secretary, the Illuminating Engineering Society, 32 Victoria Street, London S.W.1.

AUTOMATIC BOILER CONTROL

THE Combustion Engineering Association will hold a conference on the 'Automatic boiler house' at the Royal Hotel, Scarborough, on the 3rd and 4th November 1959. It will cover smaller industrial boiler plant using solid fuel.

The technical sessions are entitled 'Fuel and ash handling',

'Combustion and mechanical firing', 'The principles of automatic combustion control', and 'The application of automatic control'. After group and open discussions the final session will assess the economics of installing automatic handling and control equipment.

Full details of the conference are available from the Association, 70 Jermyn Street, London S.W.1.

RADIO HOBBIES

THE International Radio Hobbies Exhibition organized by the Radio Society of Great Britain will be held at the Royal Horticultural Society's Old Hall, Westminster, London S.W.1 from the 25th to 28th November 1959 from 11 a.m. to 9 p.m. daily (admission 2s.). A special feature will allow visitors to operate and compare communication receivers of the world.

I.R.E. CANADIAN CONVENTION

THE 1959 Convention and Exposition on Electronics and Nucleonics sponsored by the Canadian Sections of the Institute of Radio Engineers is being held at the Automotive Building, Exhibition Park, Toronto, Canada on the 7th, 8th and 9th October 1959. The office of the convention is at 1819 Yonge Street, Toronto 7.

ELECTRONICS RELIABILITY

THE 6th national symposium on Reliability and quality control in electronics will be held on the 11th–13th January 1960 at the Statler-Hilton Hotel, Washington, D.C. The symposium is sponsored jointly by the Institute of Radio Engineers, the American Society for Quality Control, the American Institute of Electrical Engineers, and the Electronic Industries Association.

ARTICLES IN THE TECHNICAL PRESS

TO enable the technical Press to publish as soon as possible new material of topical interest dealt with in papers accepted for reading before The Institution an author of such a paper is at liberty to offer a more popular, less technical and shorter article for publication in the technical Press before the reading of his formal Institution paper on the same subject provided that the article does not appear before the paper has been published and that the article makes reference to the paper.

Similarly the author of a paper which has been accepted for publication only may proceed forthwith to prepare an article for the technical Press, but it must not appear before the paper has been published in the *Proceedings* or as a *Monograph* and it must make suitable acknowledgment.

Contents of the current *Proceedings*

The date in italics is that of the Journal review, special article, or synopsis. Where given the date in capitals is the month in which a paper or monograph was published individually (see p. 555)

PART A. POWER ENGINEERING (AUGUST 1959)

See the Journal for August 1959, p. 487

PART B. ELECTRONIC AND COMMUNICATION ENGINEERING (JULY 1959)

See the Journal for August 1959, p. 487

PART C. MONOGRAPHS (SEPTEMBER 1959)

C. H. LINDSEY, M.A., PH.D. 327M, FEBRUARY 1959 **Square-loop ferrite core as a circuit-element** *February 1959*

O. P. D. CUTTERIDGE, M.SC.(ENG.), PH.D. 328M, FEBRUARY 1959 **Stability criteria for linear systems** *February 1959*

E. KUFFEL, M.SC. 329M, FEBRUARY 1959 **Effect of irradiation on the breakdown voltage of sphere-gaps in air under direct and alternating voltages** *February 1959*

C. V. JONES, M.ENG., B.SC. 330, MARCH 1959 **Method of series summation and its application to the electric force in sphere-gaps** *March 1959*

D. Q. MAYNE, M.SC.(ENG.). 331E, MARCH 1959 **Transient response of band-pass filters to modulated signals** *March 1959*

L. LEWIN. 332E, APRIL 1959 **Efficiency of a ferrite as a microwave mixer** *April 1959*

P. HAMMOND, M.A. 333, MAY 1959 **Calculation of the magnetic field of rotating machines—Part I** *June 1959*

P. J. B. CLARRICOATS, B.SC.(ENG.), PH.D. 334E, MAY 1959 **Gain of travelling-wave ferromagnetic amplifiers** *May 1959*

P. R. BRYANT, M.A., M.SC. 335E, JUNE 1959 **Order of complexity of electrical networks** *June 1959*

N. KESAVAMURTHY, M.A., B.E., M.SC.TECH., AND P. K. RAJAGOPALAN, B.E., M.S. 336U, JUNE 1959 **Rise of flux in solid iron core due to impact excitation** *June 1959*

R. LEVY, M.A. 337E, JUNE 1959 **Guide to the practical application of Chebyshev functions to the design of microwave components** *June 1959*

S.-Y. KING, B.SC.(ENG.), PH.D. 338S, JUNE 1959 **Electric field near bundle conductors** *June 1959*

N. KESAVAMURTHY, M.A., B.E., M.SC.TECH., AND P. K. RAJAGOPALAN, B.E., M.S. 339U, JUNE 1959 **Eddy currents in solid iron due to alternating magnetic flux** *June 1959*

Communicated discussion on **Production of a sinusoidal flux wave with particular reference to the inductor alternator**

Communicated discussion on **Analysis of commutation for the unified-machine theory**

District Meetings

ARRANGEMENTS for District Meetings in October other than in the area of a Local Centre

October 1959

MAIDSTONE (at the Technical College at 6.30 for 7 p.m.)

5 *Monday* E. J. SUTTON 'The National Inspection Council—two years' operation'

OXFORD (at the Southern Electricity Board Service Centre, 37 George Street at 7 p.m.)

7 *Wednesday* H. McG. ROSS 'New methods of exploiting electronic computers in the industry'

READING (at the George Hotel, King Street at 7.15 p.m.)

19 *Monday* C. A. BELCHER 'The provision of adequate installations in small houses and flats'

BULLETIN OF THE SECTIONS

ELECTRONICS AND COMMUNICATIONS

Statistics controlled

STATISTICAL techniques aid the engineer in the usually disagreeable task of taking decisions but do not absolve him from having to take them. This was the keynote of Mr. E. G. Rowe's digression into the more secluded paths of the radio-valve manufacturing business.

Mr. Rowe in presenting his lecture on 'The application of statistical techniques to the electronic-valve industry' at Savoy Place on the 13th May 1959 was concerned more with the philosophical aspects of using statistical techniques in practical situations than with the mathematical features of the techniques themselves.

Techniques work through symbols which represent information, and the information is collected and handled by human beings—who are apt to make mistakes. The whole situation is thus one in which the human element plays a much larger part than is generally recognized, and Mr. Rowe was on sound ground in saying that the really successful plant was one which had got its human relations properly sorted out. Gone were the bad old days of mutual distrust when any production man worth his salt regarded suitable manipulation of the statistical techniques as fair game in getting his rejects past the inspector and out of the factory!

Putting it across

The increasingly severe demands made on valves, particularly as regards dependability, had made the genuine use of statistical techniques a 'must' for a large part of the valve industry. Graphical methods were far superior to even elementary analysis in getting the essential facts of a situation across to supervisory staff. Histograms and control charts were instantly appreciated and easily compiled, in contrast to the derivation of mean and standard deviations which after a time take on the character of remoteness and unreality.

After commenting on the importance of realistic limits, relationship between number of samples tested and cost, methods of sampling and testing accuracies Mr. Rowe summarized his attitude to the use of statistics in radio-valve manufacture. He emphasized that statistics should be kept firmly in its proper place as a tool and that the production engineer should avoid being lulled into thinking that all problems could be solved by use of the technique.

Opening the discussion Mr. R. Brewer could not avoid a tilt at those other components (presumed to lack the leaven of statistical control which valves now enjoyed) which had for so long avoided their fair share of the blame for faults in electronic equipment. He stressed the importance of having information in the right form: a production man was more likely to react effectively if he were told what he had done wrong rather than merely what had gone wrong.

The manufacturer's responsibility

The topic of information feedback drew comments from several contributors. Mr. W. E. Willshaw pointed out that too much feedback can lead to instability, but Mr. Rowe thought that too much was better than none. Another speaker, a valve user, pointed out the difficulties and cost of providing detailed information on valves which had died in operation and suggested that the manufacturer had some responsibility here.

Rounding off the discussion in a light-hearted manner Dr. G. H. Metson aided by Mr. P. P. Eckersley reminded us of the strong connection between the brewing industry and the pioneering work on statistics of 50 years ago. The meeting closed with a show of appreciation by the audience of the efforts of Mr. Rowe and his collaborators to demonstrate how in one field of British industry at any rate scientific methods are applied in a practical way.

W. E. W.

MEASUREMENT AND CONTROL

Nervous electricity

AT the meeting on the 5th May 1959 at Savoy Place Prof. A. L. Hodgkin, M.A., F.R.S., gave the Section's Annual Lecture which was on 'The propagation of electrical signals along nerve fibres'. Mr. C. G. Garton was in the chair.

The combination of Prof. Hodgkin's reputation and the subject—which could hardly be closer to everyone's heart—attracted an excellent attendance. The Tea Room to which the meeting was exiled because of building work suited Prof. Hodgkin's air of informed informality quire admirably. One certainly expected from the title that the subject would be interesting, but dealt with as it was it proved quite fascinating.

The mechanism of the transmission system in nerve fibres is very different from anything so far designed by communication engineers. The basic signal transmitted along the fibre is a d.c. pulse continuously repeatered, so that the pulse amplitude is independent of distance. There is only one type of signal, and that is of constant amplitude but variable pulse frequency. Variations in the amplitude or intensity of stimulation are transmitted by varying the pulse frequency of the signal and the number of circuits brought into use.

The transmission system depends on a higher concentration of potassium ions inside a nerve fibre than in the surrounding medium where the concentration of sodium ions is higher. The boundary membrane in the resting state is relatively permeable to potassium but not to sodium ions. A large transient increase in its permeability to sodium ions occurs when the fibre is depolarized by an electric stimulus or by a flow of current from the adjacent region of active nerve. A quantity of sodium ions then enters the fibre and reverses the potential difference across the membrane.

The lyrical nodes

One type of nerve fibre has a continuous and homogenous boundary membrane, and the d.c. pulse formed travels smoothly along as the area of successive depolarization and polarization moves forward. Another type of nerve fibre has a

high-resistance sheath interrupted at intervals by permeable rings (nodes) through which conduction can take place by polarization and depolarization as in the continuous boundary membrane. In this 'saltatory' transmission the d.c. pulse regenerates itself at each of these nodes which are called somewhat lyrically the nodes of Ranvier. Prof. Hodgkin showed how the waveshape of the transmission pulse had been calculated theoretically and found to agree admirably with experiment.

There was a considerable discussion following the lecture, and surprise was expressed that intensity of sensation was not an amplitude phenomenon in individual fibres but a function of the number of fibres or channels brought into use. There was confusion in some minds between the mechanism of transmission to which Prof. Hodgkin had largely confined himself and the receptor mechanism—the sensation transducer, so to speak—but this was soon cleared up.

Understanding ourselves

Prof. A. Tustin in proposing a vote of thanks spoke of the difficulties inherent in biological experiments of the kind described by Prof. Hodgkin owing to the minuteness and fleeting nature of the specimens. Brilliant experimental techniques both mechanical and electrical must have been developed in order to establish the mechanism described. He felt that perhaps we were approaching the next big step forward and that following the upsurge in physical knowledge there might well be an even greater one in the biological field bringing with it a greater understanding of ourselves.

Mr. W. C. Lister seconding the vote of thanks mentioned the great interest being shown at the moment by engineers in biological problems and biologists in engineering. The Medical Electronics Discussion Group sponsored by The Institution had been consistently well supported by biologists and engineers; and recently The Institution of Mechanical Engineers had held a very successful symposium on biomechanics. Prof. Hodgkin's lecture was thus both timely and topical, and we were particularly fortunate in hearing from a man who had broken new ground not only in biology but in engineering. W. C. L.

North and West of London

BRIEF mention has been made in past Bulletins of the programmes of the Supply Groups. Below are given a few details of their activities as reported by their representatives.

North-Western Supply Group

THE 1958–59 Session of the Supply Group was successful in respect of both attendance and quality of discussion, and the Committee and participants are to be congratulated on maintaining the high standard. All the meetings were held in Manchester at the Engineers' Club.

The first meeting on the 21st October 1958 was attended by 104 members when E. P. G. Thornton and D. H. Booth read their paper on 'The design and performance of the gas-filled cable system'. The interest taken in this subject and the subsequent discussion must have been gratifying to Mr. Thornton who is a member of the Group Committee.

The meeting on the 25th November was especially interesting not only because of the scope and popularity of the paper but also because of the presence of the Centre Chairman, Prof. F. C. Williams. The introduction by Messrs. Winfield, Wilcox and Lyon of coloured films as an aid to their paper on the 'Design of the 300kV transmission system for Rhodesia' was appreciated by the 86 members present.

'Standardization of control facilities for the British Grid' by P. F. Gunning and 'The development of communication, indication and telemetering equipment for the British Grid' by G. A. Burns, F. Fletcher, C. H. Chambers and P. F. Gunning were read on the 27th January 1959, and great interest was shown in the papers and in the equipment displayed. The attendance was average, some 78 members being present.

Both Mr. K. L. Stretch and the Calder Hall power station are well known to us in the north-west, and many have had the opportunity of listening to Mr. Stretch's experiences with the station. This may account for the fact that on the 23rd February only 39 members attended to hear 'Operational experience at Calder Hall', but as at previous meetings the discussion had to be terminated because of the lateness of the hour.

SUPPLY

It was not until the last meeting on the 14th April 1959 that Mr. D. P. Sayers, Chairman of the Supply Section, was able to visit us, but there is no doubt that the 73 members present much appreciated the effort he had made. Mr. Sayers took the opportunity of expressing his regard for the junior members of The Institution and hoped that senior members would use their powers of persuasion in pointing out to young engineers the advantages of joining. Among those who listened to the paper on 'The development of h.v. air-break circuit-breakers' by F. S. Fay, J. A. Thomas, D. Legg and J. S. Morton was Mr. Bertram Thomas, one of the oldest members of the Engineers' Club. J. W.

Western Supply Group

Autumn visit 1958

THE 1958 Autumn Visit was held on the 4th October 1958 on the northern side of the Bristol Channel. Members and their ladies from Bristol and district met their colleagues from South Wales at Severn Tunnel Junction after some delay due to severe flooding on the main road between Cardiff and Newport.

The party visited the British Railways pumping station, Sudbrook, at the north end of the Severn Tunnel. About 90 members and their ladies took lunch at Tintern. After lunch they visited the ruins of Tintern Abbey and travelled by coach to the Forest of Dean for a buffet tea in Verderer's Court at the Speech House Hotel.

Meetings

Six meetings were held during the 1958–59 Session, three at Cardiff, three at Bristol. The average arrendance was 58 (47 members). We were delighted to welcome the Section Chairman, Mr D. P. Sayers, at the April meeting in Bristol.

Autumn visit 1959

The 1959 Autumn Visit will be held on the 3rd October and will include a tour of the dock installations at Avonmouth in the morning and a visit to Berkeley Castle in the afternoon. A. G. M.

South Midland Supply and Utilization Group

Meetings

As in 1958–59 it was the turn of one of our utilization colleagues to occupy the chair the majority of papers dealt with utilization subjects.

Two supply papers were presented, 'The design and application of large solid-rotor asynchronous generators' by P. Richardson on the 10th November 1958 and 'The design and performance of gas-filled cables' by E. P. G. Thornton and D. H. Booth on the 9th March 1959. The utilization paper 'Supply voltage and current variations produced by a 60-ton 3-phase electric arc furnace' presented by B. C. Robinson and A. I. Winder on the 9th February was however of particular interest to supply members.

A joint meeting was held with the South Midland Centre on the 1st December 1958 when papers on communication and control facilities for the British Grid were read and we were fortunate to be visited by Mr. D. P. Sayers, the Supply Section Chairman.

The average attendance was only 48, barely two-thirds of the previous sessional average, and we are looking forward to an improvement next year.

Summer Meeting

At the Summer Meeting on the 13th May 1959, 36 members and ladies visited a Leicester lamp factory which concentrates on discharge and automobile lamps.

Honorary Secretary H. C. Fox organized his usual sidelines during the meeting, and both the Chairman and the Past-Chairman were among the prize-winners. No Committee meeting has yet been held to discuss this coincidence. R. A. Y.

It would be odious to make comparisons between the efforts of the various Supply Groups. It is a good sign of the strength of the supply industry when we see the results which these comparatively young Groups are producing and the interest being created.

Spaces and Faces

The retirement from office of a number of Supply Section Committee members will create vacancies which will be filled mostly by newcomers to the Committee. It is necessary to ensure that representation of all interests is maintained, bearing in mind the ever-changing nature of the activities.

From Dr. J. R. Mortlock, the Chairman-Elect, the Committee will have excellent guidance. He is an eminent engineer whose work is internationally known and who has done much to further the objects of The Institution. The new Vice-Chairman, an ex-Committee man, will be the redoubtable Mr. D. B. Irving whose activities in the supply of electricity with special emphasis on the employment of cables need only be mentioned. The newcomers, C. J. O. Garrard, W. D. Horsley, D. McDonald and T. W. Wilcox, really need no introduction.

Mr. Garrard has been Chairman of the South Midland Centre, and his interests in switchgear and transformers and in the wider field in which he is now functioning, together with his personality, make him an asset to the Section. Mr. Horsley from the home of the steam turbine and the turbo-generator will be welcomed as an expert in his own province and as an experienced Institution man, having occupied the chair of the North-Eastern Centre.

Mr. McDonald will add to the element from over the Border. He has already served on the Council and has made his name in studies associated with static electromagnetic machinery, now extended to the dynamic variety. Mr. Wilcox's versatility was demonstrated on the occasion of the presentation with his colleagues of a recent paper on the scheme for Rhodesia which includes the Kariba power station. He also has been Chairman of the North-Eastern Centre.

Membership of the Committee is no sinecure, and many demands are made on those taking office. It is with confidence however that members of the Section can look forward to the future in the hands of the old and new officers. F. C. W.

UTILIZATION

Looking forward

As briefly announced in the July (emergency) issue of the *Journal* we shall welcome Mr. T. E. Houghton as Chairman of the Section Committee in the coming session and Dr. H. G. Taylor, Director of the Electrical Research Association and past-member of the Committee, as a new Vice-Chairman.

In view of the wide diversity of interests to be represented on the Section Committee the Council have agreed that the number of Ordinary Members of the Committee should be increased progressively during the next three years from 12 to 15, and in consequence we shall have five new members to replace the four who are due to retire on the 30th September 1960.

It was felt particularly desirable that contact with the traction field should be strengthened, and it is pleasing to note that Mr. J. A. Broughall of the British Transport Commission who is a past member of Council has been elected to serve on the Committee. The interest of the Electricity Boards will be maintained through the election of Mr. J. R. Anderson who has represented the South Midland Supply and Utilization Group on the Committee during the present session.

Mr. J. Tozer who has previously served on behalf of the North-Western Utilization Group is with a well known firm of consulting engineers and has taken an active part in discussions at The Institution. On the contracting side we welcome Mr. S. L. M. Barlow, a Past-President of the Electrical Contractors' Association.

The need for representation of that part of the electrical manufacturing industry which serves the mining industry has been noted, bearing in mind the large amount of electricity that is used in the coal-mines, and Mr. O. T. Evans who has a wide experience in this field should prove a very useful member of the new Committee.

Adequate electrical installations

The symposium on the Provision of adequate electrical installations in buildings, a brief account of which was given on p. 55 of the January 1959 *Journal*, has attracted considerable interest in the local Centres and is to be presented again at many of these in the coming session.

It is to be hoped that discussion of this subject may kindle in all who deal with the design and specification of installation work a fire of enthusiasm for more adequate installations throughout the country. It is encouraging to note that contractors, architects and other interested parties are being invited to attend these local meetings and to take part in the discussion of this important subject. R. A. M.

News from the Centres

WEST WALES (SWANSEA) SUB-CENTRE

Summer Visit

THE Summer Visit took place on the 20th June 1959 when a party of 21 visited the Severn Tunnel pumping station at Sudbrook and the Severn Wildfowl Trust at Slimbridge. The journey was accomplished by train and coach on a real summer's day with lunch at Gloucester and tea at Ross-on-Wye.

At Sudbrook we saw the main pumping equipment for the 4-mile-long Severn Tunnel. The waters come from two sources, the drainage from the English and Welsh approaches of the tunnel and the great underground spring encountered in 1879 when the tunnel was under construction. Up to 20 million gallons of water are pumped daily by Cornish beam engines, one of which has a beam estimated to weigh 23 tons and a 75 in.-diameter steam cylinder. Running smoothly, she was like a Victorian lady rustling her silks.

We also examined the 27 ft-diameter ventilating fan which displaces a maximum of 800000 ft^3 of air per minute and is driven by a horizontal tandem compound steam engine. We were fortunate to see the celebrated old beam engines and pumps as they are shortly to be replaced by electrically driven machines.

The Wildfowl Trust claims to have the largest and most varied collection of ducks, geese and swans in the world. There are some 1500 different species including the Whistling swan, Richardson's goose, Hawaiian duck and the rare Ne-Ne geese which have been saved from extinction. We were stimulated by the work done by the Trust under the direction of Peter Scott and felt that our visit was well worth while, but although we met many beautiful and interesting wildfowl no one was able to spot a Bombay duck.

A. E.

MERSEY AND NORTH WALES CENTRE

Annual events

FOR the Annual Summer Meeting held on the 13th June 1959 a very full day included a visit to the Shakespeare Memorial Theatre at Stratford on Avon for a matinée performance of 'Othello' featuring Paul Robeson and Sam Wanamaker.

Members and ladies with the Chairman and Mrs. Collins made an early start from Birkenhead station by special Diesel-electric train to Rugby for a tour of the English Electric Co.'s works.

In the hydraulic research laboratories we were shown models for assessing the performance of large water turbines such as those being built for the Ffestiniog scheme, and in the steam-turbine erection shop we saw 200 MW sets in course of erection.

As guests of the Company the party were taken by motor coach to Stratford on Avon and there entertained to lunch at the Shakespeare Hotel and to afternoon tea in the theatre tea-rooms after the performance. We record our grateful appreciation of the hospitality afforded by our hosts and the charming efficiency of Mr. V. F. Knight who on their behalf took care of us so well.

Free time was spent visiting places of interest in the town or on a conducted tour of the theatre museum and art gallery.

High tea served on the train home provided the final touch of comfort and relaxation to a most enjoyable day.

Golf

The Annual Golf Tournament was held in fine weather at the Southport and Ainsdale Golf Club on the 23rd June. The G. P. Dennis Challenge Trophy open to Institution

Members of the Mersey and North Wales Centre with their ladies outside the Rugby works of the English Electric Co.

members was won by Mr. A. Ratcliffe with 37 points (Stableford). The winners in the open competitions were: 13 and under, Mr. G. A. Baker for the second year in succession; 14 and over, Mr. R. M. Gravett; and the Greensome, Messrs. H. Millyard and T. Gee.

There were 60 entrants, and prizes were presented after-dinner by the captain of the Southport and Ainsdale Club. Thanks go to Mr. F. J. Brown, the organizing secretary, and to the Benevolent Fund treasurer, Mr. D. Picken, who reported a gain of £80.

Annual Dinner

The Annual Dinner will be held on the 2nd November 1959 at the Grosvenor Hotel, Chester. E. W. A.

NORTH STAFFORDSHIRE SUB-CENTRE

A.G.M. and Summer Meeting

THE Annual General Meeting was held at Stoke on Trent on the 8th May 1959 when the Chairman, Mr. R. W. Palmer, reported another successful session which he thought reflected great credit on both old and new officers of the Sub-Centre. The secretary, treasurer, and the three local assistant secretaries were all 'new boys', while we also lost our Immediate Past-Chairman, Mr. H. A. P. Caddell, on his transfer to Tipton. Mr Palmer congratulated our past-treasurer, Mr. D. H. Tompsett, on his election to the Council.

In his report the Chairman announced that membership continued to rise steadily and attendance at meetings was well maintained. As a result of boundary revision we now include Crewe, Nantwich, Congleton and Sandbach, and a successful District Meeting was held at Crewe on the 21st January 1959 to welcome our new colleagues. The Annual Dance at Stone on the 28th November 1958 with 186 members and guests and the Annual Dinner at Stone on the 20th February 1959 with 118 both attracted record attendances.

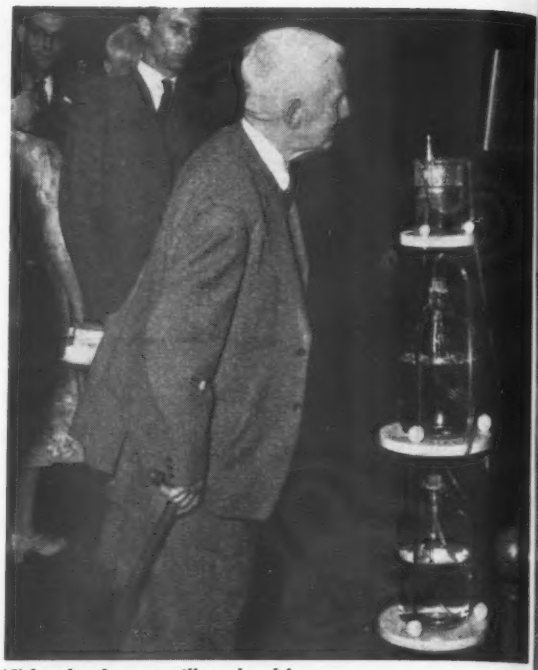
The Committee's nominees to the Sub-Centre Committee for next session were declared elected as further nominations had not been received. The retiring auditors were also re-elected.

Controlled thermonuclear reaction

At the Ordinary Meeting which followed, the Chairman welcomed Mr. R. Carruthers and invited him to deliver Mr. D. W. Fry's lecture on 'A review of work towards nuclear energy from controlled thermonuclear reaction' which described the development and use of equipment to further the research on this subject.

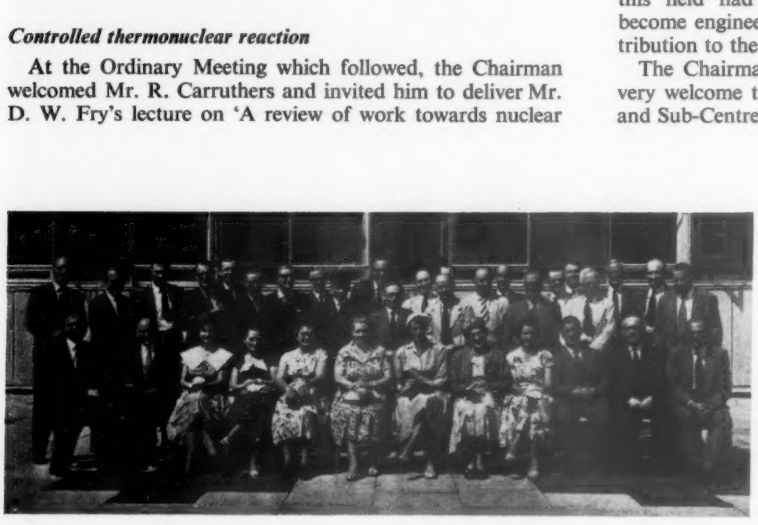
An interesting discussion was opened by Dr. T. E. Calverley who suggested that this was a good example of the valuable assistance which can be given to research workers by engineers. Mr. J. W. Gallop proposed a vote of thanks to Mr. Carruthers for his very clear exposition of Mr. Fry's lecture and his able replies to the questions. He thought that engineers entering this field had to broaden their outlook considerably and become engineer-physicists if they were to make a full contribution to the work.

The Chairman stressed that Graduates and Students are very welcome to attend all Ordinary Meetings of the Centre and Sub-Centre without any special invitation.



'I'd rather have a milk and soda'

Mr. W. Parry, Hon. Treasurer of the Mersey and N. Wales Centre, at the Centre's Summer Meeting on the 13th June 1959



The summer visit this year for members of the London Education Discussion Circle was to Crawley. In the morning the party visited Edwards High Vacuum Ltd. After luncheon at the Technical College Mr. J. Goepel, public relations officer for Crawley Development Corporation, conducted members round the town. The day concluded with a visit to Gatwick Airport

Summer Meeting

The support for the Summer Meeting at the Post Office Central Training School, Stone, on the 13th June 1959 was disappointing as only about 40 members and friends took part in this visit to a school in the heart of the countryside. It must be admitted that the beautiful day with the scents of garden flowers and new-mown hay tempted one to linger in passing from one part of the school to another.

On arrival visitors were handed a list of the demonstrations available, together with lay-out plans, and were free to follow their own inclinations rather than join a conducted tour. Staff members were available at all points to demonstrate communication equipment of all kinds from historical pieces to the most modern automatic trunk-dialling exchange apparatus and advanced v.h.f. equipment not yet in commercial use and also to show visitors round the hostel and welfare accommodation which held more direct appeal for the ladies.

The proceedings ended with afternoon tea during which Mr. A. Asbury expressed thanks to Mr. R. W. Palmer and his staff for the excellent arrangements and the leisure time they had so freely given up to ensure our interest and pleasure.

L. G.

News from abroad

ARGENTINA JOINT GROUP

Power interests

THE opening meeting of the 1958–59 Session of the Argentina Joint Group was held on the 7th April 1959 when Prof. J. M. Kay, M.I.MECH.E., Professor of Nuclear Power at the Imperial College of Science and Technology, University of London, gave a talk on 'The application of nuclear energy to power production'.

The second meeting was a luncheon held at the English club, Buenos Aires, on the 8th May, the speaker being Sir John Hacking, a Past-President of The Institution. Sir John who has been several months in Argentina told of 'Impressions gathered during a recent visit to Russia'.

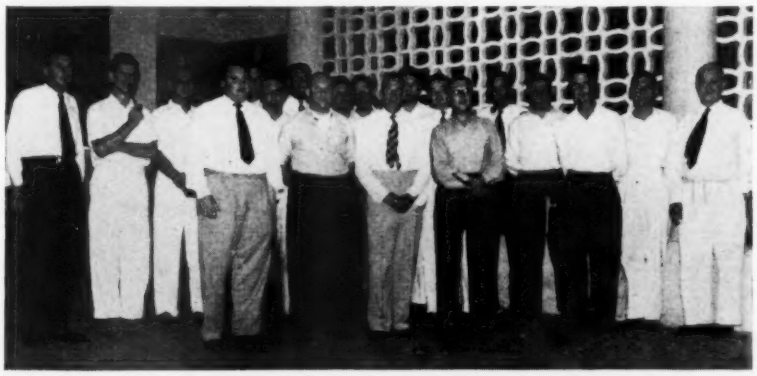
On the evening of the 14th May Mr. A. A. Rollinson, A.M.I.MECH.E., who is at present working on the new Buenos Aires power station gave a talk on 'Modern trends in power-station boiler design'.

The three meetings were well attended, and the speakers replied to a number of questions put to them by those present, who showed a great deal of interest in the subjects discussed.

A. C. T.

Hulbert at the 1958 British Plastics Conference entitled 'Twelve years of reinforced plastics'. Twenty-one members and their guests enjoyed this most interesting paper and after refreshments were given a private view of an exhibition of industrial plastics which was opened to the public the following day.

D. P. J. H.



This photograph was taken at a meeting held at the Grand Hotel, Aden, on the 27th May 1959 to consider the formation of a Joint Group for the Colony and Protectorate of Aden. The meeting decided to petition the three home engineering institutions for sanction to form the Group

TRINIDAD AND TOBAGO JOINT GROUP

June meetings

THE Group have enjoyed a comparatively active June. On the 6th June 1959 a visit was paid to the recently completed plant of Barytes and Minerals Ltd. which is on a small islet in the Gulf of Paria approximately a third of a mile from the mainland. Barytes, or barium sulphate, is extensively used in the oil industry as a drilling-fluid weighting agent, and this company processes the imported crude ore. More than 30 members were present, and the visit involved an enjoyable launch trip each way.

On the 26th June a meeting was held in Port-of-Spain to which we invited members of the Architects Association of Trinidad and Tobago. Mr. J. S. Cox, D.S.C., B.SC.(ENG.), read a paper originally presented by Brian Parkyns and G. C.

BRITISH GUIANA JOINT GROUP

Inaugural meeting

ON the 4th July 1959 the inaugural meeting of the British Guiana Joint Group was held at Georgetown. The following officers were elected: Chairman G. A. R. Farquharson, M.I.C.E.; Vice-Chairman S. C. Wilson, A.M.I.MECH.E.; Vice-Chairman P. A. Brown, A.M.I.E.E.; Honorary Secretary D. S. Fairbairn, A.M.I.C.E.; Treasurer P. J. Drury, A.M.I.C.E.; Committee members J. P. Bruen, A.M.I.C.E., H. G. Frampton, M.I.E.E., R. E. Tuckwell, A.M.I.C.E., C. A. F. Cairns, M.I.C.E., R. D. Jennings, A.M.I.C.E., J. H. Pull, A.M.I.MECH.E., R. G. Taylor, A.M.I.C.E., and E. White, A.M.I.MECH.E.

Twenty members attended, and it was decided to hold the monthly meeting on a Monday at 5.30 p.m.

D. S. F.

GHANA JOINT GROUP

Snowy Mountains scheme

THE inaugural meeting of the newly named Group was held on the 19th May 1959 at the British Council Hall, Accra, and was attended by 34 members and guests.

The Group were previously known as the West African Joint Oversea Group (Ghana Branch) formed four years ago, to which belong 160 members of the three institutions. The Chairman is Mr. T. C. M. Wigg, O.B.E., M.A., A.M.I.C.E., and the Honorary Secretary is Mr. C. D. Wilkinson, A.M.I.E.E.

Two films on the Snowy Mountains hydroelectric scheme were lent by the Australian Government, and an explanatory talk was given by Mr. H. F. Winful, A.M.I.C.E., of the Ministry of Works and Housing, who had recently returned from a visit to the project.

The Group were also honoured by the presence of H.E. the Australian High Commissioner in Ghana who made an introductory speech before the presentation of the films. Mr. Wigg gave a short address, and the officers and members nominated for the Committee were approved by those present. R. R.

HONG KONG JOINT GROUP

Foundation-laying

AT a meeting on the 24th June 1959, 65 members and their guests were addressed by Mr. M. W. Leonard, B.SC.(ENG)., M.I.C.E., A.M.I.MECH.E., on the subject of 'Foundation engineering.'

Mr. Leonard's very interesting talk was illustrated by a large selection of photographic slides; in addition to a general discussion on the subject of soil engineering he dealt with the various methods of preparing foundations including the latest grouting techniques, piling operations and equipment of all types.

The speaker was introduced by Mr. G. B. Gifford-Hull, M.I.C.E., Chairman of the Group. After Mr. Leonard had replied to various questions from the audience at the end of his address the meeting closed with a vote of thanks by Mr. J. K. M. Henry, M.I.C.E. R. A. Y.

AUSTRALIAN ATOMIC ENERGY COMMISSION

News from Lucas Heights

BY the end of 1959 the reactor Hifar at the Atomic Energy Research Establishment at Lucas Heights near Sydney will be operating at full power, and plans for its use are under discussion.

Several oversea authorities are interested in hiring space in Hifar for testing nuclear-power-reactor materials, and the U.K.A.E.A. hope to be able to irradiate samples of beryllium metal.

Its high-intensity gamma-radiation will also be used to study the preservation of food by irradiation, and a preliminary programme has been agreed for observing the effects of such processing on various foods particularly Australian meat.

A food project already being carried out at Lucas Heights is the use of a radioactive isotope as a tracer in testing the efficiency of a sugar-mill subsider which removes solid impurities from raw sugar solutions.

The technical physics section has been investigating the use of transistors in instruments for nuclear research and laboratories where radioactive materials are handled, and one of its first designs is a scaler which can be made for a third of the cost of a comparable imported instrument.

To meet the growing volume and variety of work undertaken at Lucas Heights more laboratories and workshops are being built.

A new building to house the isotopes and technical physics sections is almost completed, and accommodation for the headquarters of the Australian Institute of Nuclear Science and Engineering and for the engineering services, engineering research and metallurgy sections is at present under construction.

UGANDA

Blowing up the Nile source

IN order to effect a better outflow from Lake Victoria for the Owen Falls hydroelectric station some 60000yd^3 of rock are being blasted from the Ripon Falls, believed to be the original source of the Nile. In 1862 when Speke discovered this waterfall it was the start of the Nile's course from the lake.

Five years ago the level of the river was raised to that of the lake by the completion of the Owen Falls dam, and the waterfall was submerged leaving a rock barrier restricting the flow of water at low lake levels.

Apparently blowing up the Ripon Falls has so far done little to shatter the composure of the local hippopotamus and crocodile population.

It is reported that one hippopotamus discovering the new source of the Nile at the Owen Falls dam was unperturbed by the fast flow of water near the intake boom and was only dissuaded from further investigation by the frantic shouting of the charge engineer.

The demand for electricity from the Owen Falls station is steadily increasing since as well as meeting Uganda's growing load 10^7kWh per month are being supplied to Kenya.

ISLAND ELECTRICITY

Comparative consumption

THE following figures relating to the consumption of electricity per capita of island populations were recently disclosed by the Bermuda Electric Light Co.

Bermuda (population 42773) now uses 1730kWh per capita per annum; Jersey (57296) 902kWh; Nassau (49494) 875kWh; Isle of Man (54499) 857kWh; Trinidad and Tobago (763420) 180kWh; and Barbados (232227) 95kWh.

OVERSEA ATTENDANCE REGISTER

DURING the period 17th July to 15th August 1959 these members called at the Institution building and signed the Attendance Register of Oversea Members:

BEADLE, P. R. (Churchill, Manitoba)
BURGESS, S. L. (Doha, Qatar)
BURLEY, V. G. (Claremont, Tasmania)
COLEMAN, W. F. (Accra, Ghana)
CROSBY, P. H. (Sydney)
DAWSON, R. J. (Jinja, Uganda)
ECKERSLEY, T. (Kampala, Uganda)
ELLIOTT, T. W. (Pretoria, South Africa)
HASHEM, A. I. (Kuwait)
ILOTT, E. C. (Winnipeg, Manitoba)
KINELATO, J. E. (Khartoum, Sudan)
KORAM, E. M. (Accra, Ghana)
LYDDIARD, J. A. (Kumasi, Ghana)
ROBERTS, C. G. (Kuala Lumpur, Malaya)
SKELTON, G. H. (Bermuda)
SMART, D. W. (Kuwait)
SMITH, D. H. (Lagos, Nigeria)
STANDEN, M. H. L. (Nairobi, Kenya)
STEWART, C. E. (Bombay)
STIRRUP, H. (Sapele, Western Nigeria)
WILSON, J. (Melbourne)
WRIGHT, P. G. (Auckland)